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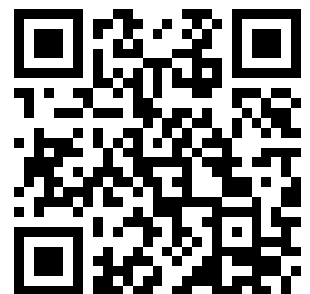
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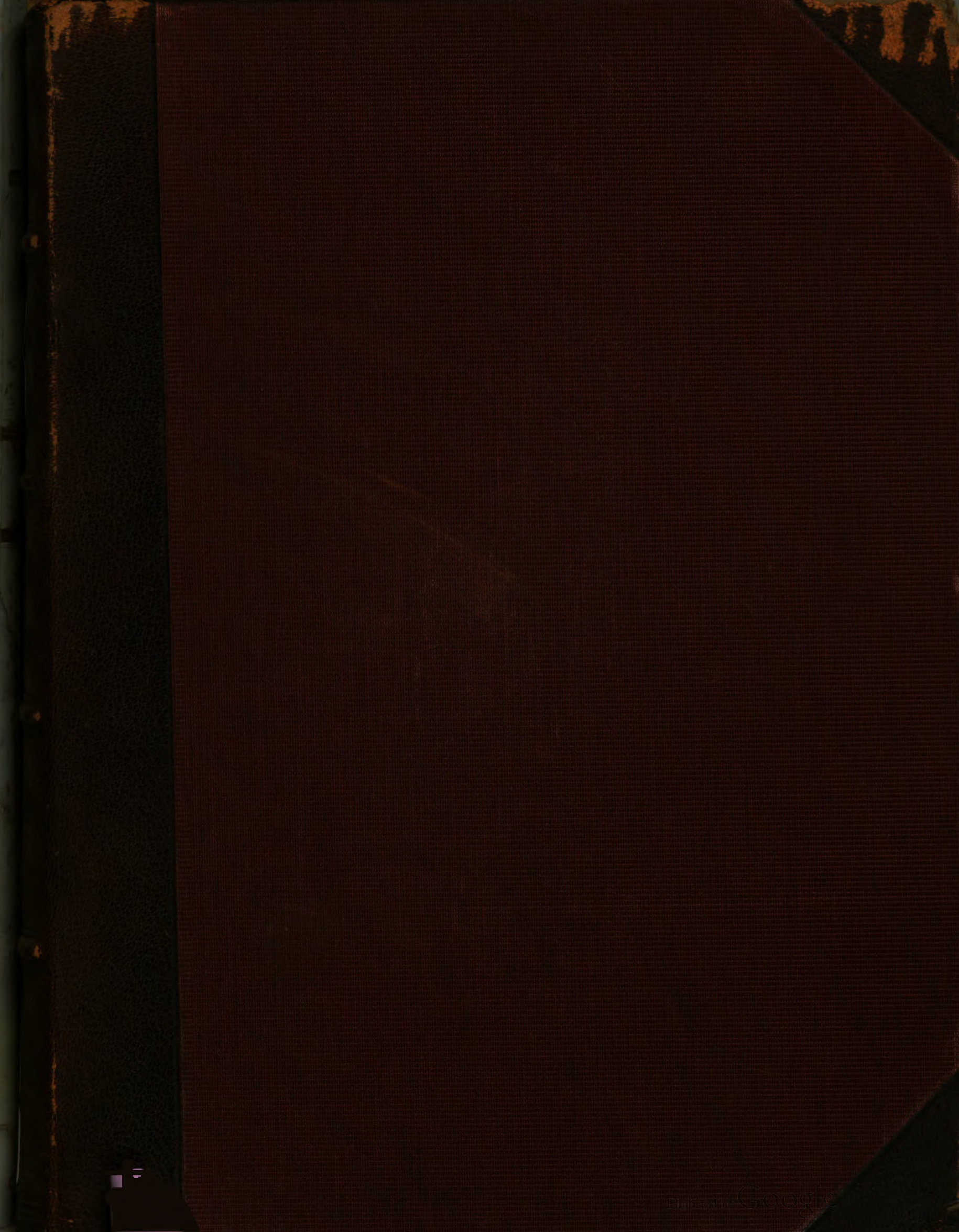
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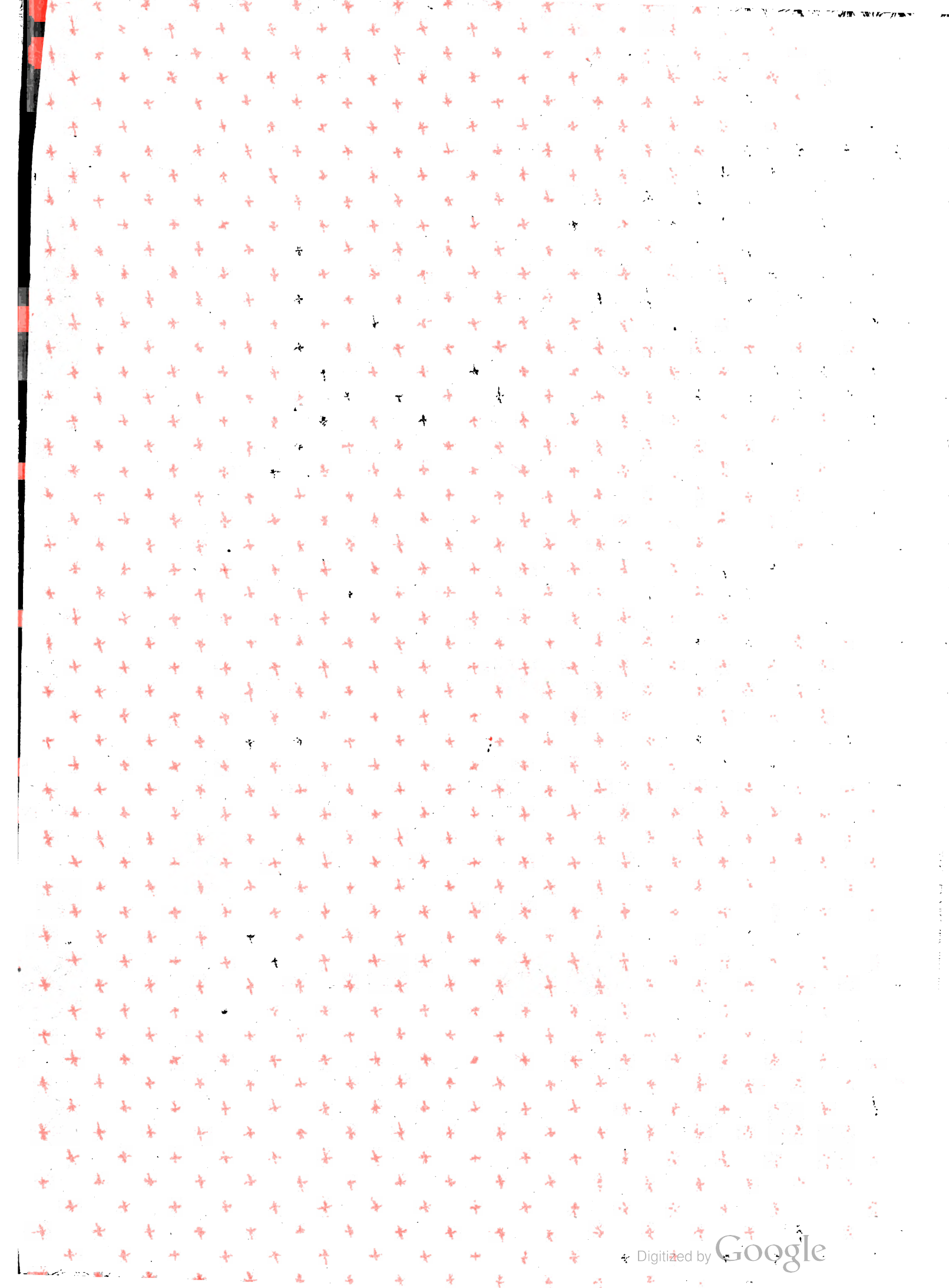


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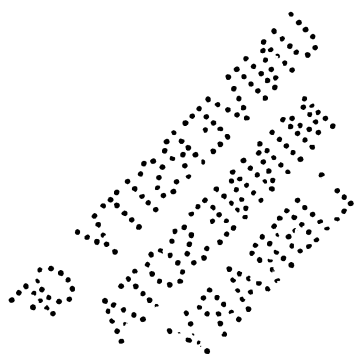
AND AFFILIATED SOCIETIES

Volume XXXIV

EDITED BY THE COMMITTEE ON PUBLICATION

PHILADELPHIA
THE ENGINEERS' CLUB OF PHILADELPHIA
1317 Spruce Street
1917

W. S. ...



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ORGANIZED DECEMBER 17, 1877

INCORPORATED JUNE 9, 1892

PUBLISHED MONTHLY BY THE ENGINEERS' CLUB OF PHILADELPHIA UNDER THE SUPERVISION
OF THE PUBLICATION COMMITTEE



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JANUARY, 1917

No. 146

CONTENTS OF THIS ISSUE

	PAGE		PAGE
Committee on Meetings.....	Inside Front Cover	Telephone Engineering.....	23
Announcement by J. C. WAGNER, Chairman		"Present Worth" Methods. By A. P. GODSHO	
Officers, Directors, Standing and Special Committees of Engineers' Club.....	2	The Traffic Department. By A. L. GRACEY	
Editorial.....	3	Central Offices and Some Types of Switchboards. By J. H. MAHON	
Committee on Papers.....	4	Illuminating Engineering Society.....	31
Announcement by LEWIS H. KENNEY, Chairman		Regular Meeting, Philadelphia Section	
Secretary's Notices.....	6	Society of Automobile Engineers.....	32
Regular Meeting of The Club, Nov. 21, 1916		Retardation, by JOHN YOUNGER	
Special Meeting Board of Directors, Nov. 22, 1916		American Society of Mechanical Engineers.....	39
Regular Meeting Board of Directors, Dec. 12, 1916		December Meeting—Philadelphia Section	
Special Meeting of The Club, Dec. 13, 1916		February Meeting—Philadelphia Section	
Business Meeting of The Club, Dec. 19, 1916		Philadelphia Association of Members of the Ameri- can Society of Civil Engineers.....	40
J. Milton Ritchie.....	8	Obstacles to Success in Engineering and Advice to Young Engineers	
Committee on Membership.....	9	By SIR MAURICE FITZMAURICE	
Candidates for Membership		American Institute of Electrical Engineers.....	44
What Philadelphia Has Done Toward Regulating and Restricting the Uses of Realty Within the City	10	December and January Meetings, Finances and Students' Night	
By JOSEPH C. WAGNER		American Society of Heating and Ventilating Engi- neers.....	47
The Asphalt Industry.....	11	Regular Meeting, Dec. 14	
From an Interview with JAMES L. RAKE		The Duty of the Engineer to His Client and Himself	
Foreign Notes.....	17, 46, 62	By STEWART A. JELLETT	
Japanese Shipping and South America		Technology Club of Philadelphia.....	56
New Nitrogen Works		Regular Meeting, Dec. 6, 1916	
More Chinese Railways		The Gas Engineer of the Last Century.....	59
Every-Day Uses of Portland Cement		Road-Testing Indoors—Value of a New Machine..	60
Gas-Engine Vibrations		Duplicate Notice of Meetings for the Pocket.....	61
Oral Engineering at the Front.....	18	Index to Advertisers.....	62
By DR. CLARK J. HOLLISTER		Industrial Notes.....	62
Professional Directory.....	22		

Permission is given to reprint any paper after its date of presentation, provided proper credit is given.

Contributions of all kinds on all topics of interest to the members of the Engineers' Club are cordially invited. All matter for publica-
tion, including advertising copy, must be in the hands of the Editor by the 20th of the month for the issue of the following month.

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SECRETARY TO THE SECRETARY

S. M. SNEDEKER

Editorial

Nearly two years have elapsed since the program of the Engineers' Club for increasing its sphere of usefulness through affiliation with local technical societies was made operative, and the success that has attended the closer association bears witness to the opportunities for better co-operation among these societies.

Most of the problems presented by the affiliation of seven engineering organizations with the Engineers' Club have been solved to the general advantage of all and a working basis for the association of technical societies in Philadelphia has been established.

Although the By-Laws of the Club were revised at the time of this joining together of the several engineering organizations, many desirable modifications have become apparent, deeming the practical working out of the affiliation idea, and the By-Laws Committee has given much time and thought to further simplification and classification.

The Club members will be called upon within a few weeks to vote upon the proposed amendments to the By-Laws, and they are asked to give this matter thoughtful consideration. The method of amending the By-Laws has already been approved by the Club, so that the general amendments about to be presented to the membership can now be voted upon without delay.

Perhaps the most radical changes proposed relate to the appointment of an executive secretary, and the simplification of the method of electing officers by use of the letter ballot.

The Club, which now has a membership of nearly 2500, is engaged upon an enterprise in which much of the work is delegated to committees, whose members must work intermittently on Club affairs, and an executive secretary should be provided who will give his entire time to the Club's interest. The proposed By-Laws provide for the annual appointment by the Board of Directors of such an officer, and he will be responsible to the Board for the proper conduct of the business affairs of the Club. Such a Secretary can do much toward solving the problems now so forcibly before us and to make possible the appointment is the next step in a development which can only be attained by persistent and consistent pressure toward a definite goal.



We are pleased to present to our readers of this issue, three papers on the subject of "Telephone Engineering", contributed by Junior members of the Club, and it is our hope that other Junior members will be encouraged to offer papers for publication.

Engineers' Club of Philadelphia

COMMITTEE ON PAPERS

LEWIS H. KENNEY, Chairman

ANNOUNCEMENT

MEETING OF JANUARY 16, 1917, at WITHERSPOON HALL

THE paper of the evening, "**Chemical Research in Philadelphia,**" will be presented by **Dr. Edgar Fahs Smith**, Provost of the University of Pennsylvania.



DR. EDGAR FAHS SMITH
Provost of the University of Pennsylvania

Dr. Smith will speak on the history of chemical research in Philadelphia, and of the applications of the results of the chemical researches to our industries.

The paper will be illustrated by lantern slides.

Members of Affiliated Societies are cordially invited to attend.

Members of the Club and of Affiliated Societies are privileged to invite ladies.

MEETING OF JANUARY 26, 1917, AT DREXEL INSTITUTE

The paper of the evening upon the subject "**The Zoning System**" will be presented by **Hon. Edward M. Bassett**, Chairman of the Heights of Buildings Commission and Chairman of the Commission on Building Districts and Restrictions, New York City.

Mr. Bassett's paper will treat of the districting of cities to regulate buildings as to the height, size and use, with especial reference to the complete districting plan recently adopted by the Board of Estimate and Apportionment for New York City. The paper will also indicate the waste of buildings due to the invasions of unsuitable uses and the larceny of light and air, and will show the relation of zoning to public health and safety.

Mr. George B. Ford, Consultant to the Commission on Building Districts and Restrictions, New York City, will also present a short paper on the above subject. The paper by Mr. Ford will present a brief review of the district plan as now in use in New York City, from its inception

COMMITTEE ON PAPERS

a few years ago, by the Honorable George McAneny, through its various stages of development from the encroachments upon the public highways, population and traffic congestion, inordinate heights of buildings and city planning, to the completed plan as finally adopted July, 1916, by the Board of Estimate and Apportionment for the comprehensive regulation of the height, size and use of buildings in the entire City of New York. In detail, the Use Districts, Height Districts and Area Districts will be briefly described and specific application will be shown upon each.

Mr. Bassett's paper will be discussed by Director of Public Works, George E. Datesman; Secretary of the Art Jury, Andrew Wright Crawford; and Engineer of City Plans, Bureau of Surveys, B. Antrim Haldeman.

Arrangements are being made for an exhibit of maps and models of **"The Zoning System."** Dr. Hollis Godfrey, President of Drexel Institute, has kindly arranged for the maps and models to be on exhibition January 26 and 27, 1917.

Members of Affiliated Organizations are cordially invited to attend.

Members of the Club and of Affiliated Organizations are privileged to invite ladies.

PRELIMINARY ANNOUNCEMENT

Preliminary announcement is made of the following meetings for the information of the membership. More detailed information will appear in the next issue of the PROCEEDINGS.

FEBRUARY 20, 1917.—*Regular Club Meeting, at Witherspoon Hall.* The paper of the evening, **"Our National Parks,"** will be presented by **Hon. Stephen T. Mather**, Assistant Secretary of the Department of the Interior.

FEBRUARY 26, 1917.—JUNIOR MEETING at Engineers' Club.—Subject **"Organization of the Bureau of Surveys."**

MEETINGS FOR JUNIOR MEMBERS

Dr. W. M. Boehm, member of the Committee, has been elected Chairman of the meetings. Attendance at the meetings will be limited to Junior Members and their guests, and Officers and Senior Members invited by the Committee on Papers.

JANUARY 22, 1917.—Meeting at the Engineers' Club—Subject **"Coal Tar Products."** The following papers will be presented:

"Historical Development, Early Discoveries and Crude Materials." By **Clark M. Dennis**.

"Refining and Uses of Products." By **Clinton Y. Wilgus**.

Junior Members are privileged to invite friends to the meeting.

PRIZE FOR JUNIOR MEMBERS

See November issue of PROCEEDINGS, Page 5, for rules governing the award of prize for Junior Members.

Engineers' Club of Philadelphia

SECRETARY'S NOTICES

ABSTRACT OF MINUTES OF THE REGULAR MEETING OF THE CLUB

HELD TUESDAY EVENING, NOVEMBER 21, 1916

The meeting was called to order by President Carter at 8.30 P.M. About 1000 members and guests were in attendance.

The minutes of the Business Meeting of October 18, as printed in the Proceedings, were approved.

ANNOUNCEMENTS

The Board of Directors elected, at its last meeting, the following to membership: Active, 20.

Major John C. Oakes was elected to Army and Navy membership from the Philadelphia Association of Members of the American Society of Civil Engineers, on November 10, 1916, and Harry P. Young was elected to Active membership from the Philadelphia Section of the American Institute of Electrical Engineers, on November 13, 1916, in accordance with Article VI, Section 1, of the By-Laws.

The following proposed amendment to Article XII of the By-Laws was presented:

Article XII

AMENDMENTS

SECTION 1. Proposed amendments to these By-Laws may be submitted directly to the Club by the Board of Directors, or may be presented in writing to the Board of Directors, signed by at least twenty-five Active Members in good standing, and, if so presented, shall be reported by the Board, with its recommendations, at the next Business Meeting of the Club before which such business may properly come. The notice of the said meeting shall give the wording of the proposed amendment, and shall state that it may then be discussed and amended.

SEC. 2. The proposed amendment shall be submitted for letter ballot within ten days from the meeting. Ballots to be considered shall be written or printed, and received through the mail or otherwise by the Tellers, not later than ten days before the next meeting of the Club, at which meeting the Tellers shall report the result of the ballot.

SEC. 3. Any amendment for which two-thirds of the ballots received are in the affirmative shall be adopted.

The paper of the evening, entitled "Military Aeronautics," was presented by Major William Mitchell, Chief of Staff, Aviation Corps, U. S. A. Following the paper,

seven motion picture reels were exhibited, entitled "War as It Really Is."

A unanimous vote of thanks was extended to the speaker.

The meeting adjourned at 11.25 P.M.

ROBERT H. FERNALD,
Secretary.

SPECIAL MEETING OF THE BOARD OF DIRECTORS

NOVEMBER 22, 1916

The meeting was called to order at 8.30 P.M. by President Carter, with Vice-Presidents Vogleson and Yarnall, Directors Wagner, Liversidge, Gibson, Cassell, Past Presidents Taylor and Swaab and Secretary Fernald in attendance. Vice-President Andrews, Directors Murray, Temple, Crampton, Foljambe, Bachman, Past President Ledoux and Treasurer Irish were absent.

Mr. J. F. Stevens, Chairman of the Committee on By-Laws, was also present.

The proposed changes in the By-Laws were discussed, and several minor changes made.

Action: It was moved and carried that the proposed By-Laws, as revised, be presented to the Club.

A vote of thanks was extended to the Committee on By-Laws.

The meeting adjourned at 9.55 P.M.

ROBERT H. FERNALD,
Secretary.

REGULAR MEETING OF THE BOARD OF DIRECTORS

DECEMBER 12, 1916

The meeting was called to order by President Carter at 8.30 P.M., with Vice Presidents Vogleson and Andrews, Directors Murray, Wagner, Gibson, Crampton, Past Presidents Taylor and Swaab, Secretary Fernald and Treasurer Irish in attendance. Vice President Yarnall, Directors Liversidge and Temple were excused. Directors Foljambe, Bachman and Cassell and Past President Ledoux were absent.

The minutes of the Regular Meeting of November 14, and of the Special Meeting of November 22, as issued to the Board of Directors, were approved.

The President spoke on the question of Club Development, and announced that he had appointed the following Committee to take care of this subject:

S. M. Swaab, Chairman	W. L. Plack
J. H. M. Andrews	M. M. Price
J. F. Murray	

A report was presented from the Chairman of the

SECRETARY'S NOTICES

Committee, suggesting certain material improvements to the present club house.

Action: The question of using the room now occupied by the library as an addition to the restaurant was referred to the Committee on Club Development, with power to act, after consulting with the Chairman of the Committees on Library and on House.

REPORT OF THE SECRETARY

The following resignations from members in good standing were presented:

C. E. Brinser	H. B. Cornog
H. K. Cortright	H. deC. Hamilton

Action: Resignations accepted as of March 31, 1917. Announcement was made of the appointment of J. H. M. Andrews as a member of the Committee on Publicity, vice Joseph Caccavajo, resigned; and of the appointment of John P. Mudd as a member of the Committee on Publication.

Action: Report accepted.

REPORT OF THE TREASURER

The Treasurer reported that the bank balance December 1 was \$7098.84, and the balance on November 1 \$9007.39, a decrease during the month of \$1908.55.

Action: Report accepted.

REPORT OF THE COMMITTEE ON FINANCE

The Chairman presented a report, showing the unexpended balances of the various appropriations, and a balance of \$579.49 in the total estimated income, after deducting the authorized appropriations.

Action: Report accepted.

REPORT OF THE COMMITTEE ON HOUSE

The Chairman reported a profit in Club house business for the month of December of \$21.97, and in the restaurant account of \$8. The number of meals served during the month of November was 2343, as against 1870 in October, an increase of 25 per cent. He stated that this increase in the use of the restaurant was due to the establishing of Club breakfasts and Club dinners, at special rates.

The Chairman called attention to the urgent necessity of additional restaurant space, in order that private diners for large numbers might be served without interfering with the service to the regular patrons.

It was announced that arrangements for the usual New Year's Reception had been made, and that the Manager had been authorized to proceed with the usual Christmas Fund collection for the Club employees.

Action: Report accepted.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The Committee recommended the following applicants for election to membership in the Club:

Edward G. Allen	Roy H. McMasters
Thomas Wesley Allison	Archie C. Seibert
Perry E. Beam	Henry K. Shaw
John Harmer Gilmer	Russell Everett Shaw
Franklin M. Hoover	William M. White
William H. Kavanaugh	

Action: Recommendation approved.

REPORT OF THE COMMITTEE ON PUBLICATION

The Chairman presented to the Board the full minutes of the meeting of the Committee of December 12. It was suggested that the name of the Club publication be changed from "Proceedings" to "Journal." Owing to the fact that the proposed new By-Laws do not specify any name for the Club publication, it was suggested that no action be taken on this matter until the By-Laws are adopted.

The Chairman stated that arrangements had been made to publish abstracts of the Junior papers on "Telephone Engineering" in the PROCEEDINGS.

An appropriation of \$250 was requested.

Action: The amount of \$250 was transferred from the appropriation of the Committee on Club Development to the Committee on Publication, subject to the approval of the Committee on Finance.

Report of the Committee accepted.

REPORTS OF THE SPECIAL COMMITTEES

Committee on Public Relations

The Committee presented a report.

Action: Report accepted.

Committee on By-Laws

The Committee presented a report, suggesting that an official Club emblem be adopted.

Action: Report accepted, and the following style adopted, to be made up in solid gold and black enamel. The charge to members for the emblem, including safety catch, is to be \$2.50.

(Sketch of pin shown on official copy of minutes.)

ABSTRACT OF MINUTES OF THE SPECIAL MEETING OF THE CLUB

HELD WEDNESDAY, DECEMBER 13, 1916

The meeting was called to order at 8.30 P.M. by Past President Hering, with about 200 members and visitors in attendance.

The Assistant Secretary announced that Dr. Dixon, who is associated with Mr. Rodman Wanamaker in the study of the Life of the American Indian, would probably give a talk before the local section of the American Society of Civil Engineers on January 4, and that members of the Engineers' Club of Philadelphia are invited to attend this lecture.

Mr. Laurence D. Kitchell gave a lecture, illustrated by lantern slides and motion pictures on "Glacier National Park and the Blackfeet Indians."

A unanimous vote of thanks was extended Mr. Kitchell.

The meeting adjourned at 10.30 P.M.

J. M. RITCHIE,
Assistant Secretary.

ABSTRACT OF MINUTES OF THE BUSINESS MEETING OF THE CLUB

HELD TUESDAY, DECEMBER 19, 1916

The meeting was called to order by President Carter at 8.25 P.M. About 150 members and guests were in attendance.

ANNOUNCEMENTS

The Board of Directors elected, at its last meeting, the following to membership: Active, 11.

Mr. J. M. Ritchie was elected to active membership from the Philadelphia Association of Members of the American Society of Civil Engineers, on December 18, 1916.

The proposed amendment to Article XII was accepted as printed, and ordered for letter ballot.

The following resolution was adopted:

"Recognizing the confusion, inconvenience, and loss of time and efficiency occasioned by the lack of uniformity in recording temperatures in this country; and recognizing further that the Centigrade scale is much simpler and more convenient than the Fahrenheit scale and is the present standard in all other countries, except Great Britain, and is also in general use among scientific men throughout the world:

"It is the sense of this meeting of The Engineers' Club of Philadelphia, that the efforts being

made to obtain legislation requiring the use of the Centigrade scale in all future Government publications should be heartily approved."

The paper of the evening, entitled "Economics of Power Plants," was presented by Mr. Francis R. Weller, and was discussed by Messrs. George R. Henderson, John D. Gill and E. G. Perrot.

A unanimous vote of thanks was extended to the speaker.

The meeting adjourned at 10.25 P.M.

J. M. RITCHIE,
Assistant Secretary.

A Business Meeting of the Club will be held at Wither- spoon Hall on Tuesday, January 16, 1916, at 8.15 P.M.

Business: The proposed amendment to Article XII of the By-Laws will be voted upon.

Ballots will be received by the Tellers between 8.15 P.M. and 9.15 P.M., and must be deposited in person or by proxy. Ballot, proxy and copy of present By-law and proposed amendment have been sent under separate cover.

Paper: Dr. Edgar Fahs Smith, Provost of the University of Pennsylvania, will address the meeting on "Chemical Research in Philadelphia"

ROBERT H. FERNALD,
Secretary.

J. MILTON RITCHIE



J. M. RITCHIE

THE resignation of J. Milton Ritchie as Assistant Secretary and Business Manager of the Engineers' Club went into effect on January 1, but his many friends will be pleased to note that he has been elected to active membership in the Club.

With the beginning of the year, Mr. Ritchie became the local Sales Manager of the Pennsylvania Cement

Company with headquarters in the Land Title Building.

Mr. Ritchie is a graduate of the Philadelphia Manual Training High School, having been born in this city on January 22, 1882. Immediately after leaving school, he secured a position as draftsman in the Engineering Department of the Bell Telephone Company, later becoming Assistant to the Engineer of Construction on Underground Conduit Work of the Bell Company, leaving there to accept a position as draftsman in the Highway Supervisor's office of the City of Philadelphia, where he remained for four years. He spent six years in the Bureau of Surveys, General Plan Division, as draftsman and chief draftsman.

In May, 1912, Mr. Ritchie accepted the position as Business Manager of the Engineers' Club, but continued to act as Secretary of the Special Committee on Rearrangement of the Interior of the City Hall, of which Committee the Mayor, President of Common Council, City Solicitor, and the Director of Public Works were members until July, 1913.

A complimentary dinner was given Mr. Ritchie at the Club a few days before Christmas, which was attended by many warm friends of the guest of honor, who presented him with a magnificent watch as a token of appreciation of his faithful and painstaking work in the interest of the Club during the past five years.

Engineers' Club of Philadelphia

COMMITTEE ON MEMBERSHIP

D. ROBERT YARNALL, Chairman

CANDIDATES FOR MEMBERSHIP

Members having knowledge of the candidates are invited to submit to the Committee on Membership before January 8th a confidential expression of opinion as to the eligibility of the candidates; all communications to be addressed, "Chairmen of the Committee on Membership, Engineers' Club, Philadelphia," marked "Confidential."

All applications are on file at the Club and can be referred to by any member.

FOR ELECTION TO ACTIVE MEMBERSHIP

GUSTAV A. H. BINZ

205 E. Upsal St., Gtn., Phila., Pa.

Supt. Meter Dept., Yarnall-Waring Co.

Proposed by D. Robt. Yarnall and Wm. H. Gomersall.

LOUIS K. CARROLL

c/o Tindel-Morris Co., Eddystone, Pa.

Supt., Tindel-Morris Co.

Proposed by D. K. Bullens and J. E. McKee.

WALTER JOSEPHUS DENNY

Ardmore, Pa.

Mechanical Engineer, Representative, Waterbury Mfg. Co., Waterbury, Conn.

Proposed by Lawrence P. Kellogg and Robert M. Barr.

ROLLIN LESTER DIXON

John Wanamaker, Indian Bureau & Educational Bureau, Philadelphia, Pa.

Ethnologic research; Anthropology. For Rodman Wanamaker. Former Active Member Company "B" Engineer Battalion, N. G. P.

Proposed by Moriz Bernstein and John G. Worth.

DAVID SCOTT FERREE

25 N. 34th St., Phila., Pa.

Chief Engineer, Maris Bros.

Proposed by M. L. Mosher, Lester M. Goldsmith and Albert H. Schmidt.

CHARLES EBEN FISHER

3309 Arch St., Phila., Pa.

With Pennsylvania Railroad.

Proposed by Walter M. Mitchell, H. T. McGaughan and W. P. Parker.

CHARLES LEWIS GULICK

4221 Osage Ave., Phila., Pa.

Special Representative, Tindel-Morris Co.

Proposed by D. K. Bullens and Joseph A. Steinmetz.

SAMUEL K. HASLAM

West Phila. High School (Boys)

Instructor Manual Training W. P. H. S.

Proposed by John H. Nutall and Wm. A. Schnell.

HAROLD C. LIGHTFOOT

1305 Wakeling St., Phila., Pa.

Civil Engineer, Pugh and Hubbard.

Proposed by Marshall R. Pugh and Fred C. Dunlap.

EDWARD T. PETERS

360 Church Lane, Gtn., Phila., Pa.

Sales Engineer, Dexter Portland Cement Co. (Former member.)

Proposed by J. Reese Bailey, Clifton Peale and Walter F. Drueding.

ROLAND LEE RUDRAUFF

3240 N. 15th St., Phila., Pa.

Ass't. Professor, Dept. of Drawing & Design, Gtn. High School.

Proposed by Alfred Ames Townsend and Fred C. Dunlap.

WILLIAM POPE SNOW

220 W. 42nd St., New York, N. Y.

Manager Railway Dept., Railway, Audit & Inspection Co.

Proposed by M. J. McCleary and Moriz Bernstein.

FOR ELECTION TO JUNIOR MEMBERSHIP

EDWARD M. BREDIN

729 N. 63rd St., Phila., Pa.

Instructor in Electrical Engineering, U. of P.

Proposed by R. H. Fernald and J. V. Stanford.

ROBERT ELLSWORTH FRITSCH

1910 Medary Ave., Logan, Phila., Pa.

Assistant Engr., E. E. Brownell Engr. Co.

Proposed by E. E. Brownell, H. S. Murphy and J. H. M. Andrews.

ENGINEERS' CLUB OF PHILADELPHIA

What Philadelphia Has Done Toward Regulating and Restricting the Uses of Realty Within the City

By JOSEPH C. WAGNER

THE 1915 Legislature of the State of Pennsylvania passed an Act, approved May 11, 1916, to promote the public health, safety, order and general welfare in cities of the first class (the City of Philadelphia) by the regulation of the location, size and use of buildings, and authorizing also the making of different regulations for different districts within the city limits.

This Act provides for the establishment of what is generally known as the Zoning System, more properly called the Districting System.

The Philadelphia City Councils, under date of July 20, 1916, authorized by resolution His Honor the Mayor to appoint a Commission to prepare a code of regulations and a draft of the legislation necessary to put the above Act of the Legislature into force. Such legislation and regulation code will require the approval of Councils before becoming operative as the law.

The Commission has been appointed and its personnel is composed of the Director of the Department of Public Works, the Director of the Department of Public Safety, the Director of the Department of Public Health and Charities, the President of the Fairmount Park Commission, the Chief Engineer of the Bureau of Surveys, a member of the Art Jury, a member of the Comprehensive Plans Commission, a member of the Operative Builders' Association, a member of the American Institute of Architects and a member of the Chamber of Commerce.

The Districting System, as defined by the Board of Estimate and Apportionment of New York City, embraces "a comprehensive plan for the control of building development on private property," and in its essence is one placing restrictions upon such property by regulating the use of buildings erected, by regulating the height of such buildings and further, by regulating the size of buildings with respect to the area of the lot occupied.

The New York law, the most recently enacted upon this subject and the most comprehensive in its scope as applicable to metropolitan cities, may be taken as a model. While the fundamental principles hold as applied to any city, yet each city must legislate for its own particular needs. New York City is divided into three classes of districts—Use Districts, Heights Districts and Area Districts.

In the Use Districts there are four general subdivisions—residence, business, unrestricted and undetermined—and the regulations apply only to future buildings. No building is to be used for any other purpose than that permitted in that district. Residence districts exclude industries and business of all kinds, but dwellings, private clubs and most institutional buildings are allowed and dwellings include apartment and boarding houses and cer-

tain classes of hotels. In residence districts, an accessory use is permitted, such as a private garage. Business districts specifically exclude certain trades or industries, the operation of which would be noxious and offensive by reason of odor, dust, smoke, gas or noise. Garages and stables are allowed under certain conditions. In the unrestricted districts, which are largely industrial, no restrictions are made. The undetermined districts are the least developed and lie mostly in the outer suburbs of the city and it is considered that restrictions cannot properly be made at the present time or until the appropriate use becomes more fully disclosed.

In the Height Districts, the height of a building is fixed generally at some ratio of the width of the street upon which it fronts, limiting the height at the street line to a varying multiple of the street width. These districts are classed as one time, one and one-quarter times, one and one-half times, two times and two and one-half times districts. In the one time district, no building is permitted higher than the width of the street; in a two and one-half times district, no height is to be in excess of two and one-half times the street width. Provision is made in each classification, however, for a building to rise above the fixed height for that district provided that beyond a fixed height the building shall set back from the street line a specified distance. Exceptions are made as to church spires, towers and belfries.

The Area Districts provide for A, B, C, D and E Districts, in each of which regulations govern the size of yards, open spaces and courts. The A Districts are generally in the central or closely built-up sections and E Districts in the outlying areas. In all of the districts certain exceptions are allowed in appropriate cases that the law, in its strict letter, may not be too drastic.

The New York law does not in any way annul any existing law or regulations or affect any permits already issued except that where the new law imposes greater restrictions than are imposed by an existing law or ordinance or regulation, the provisions of the new law control. Authority is also given the Board of Appeals, in specific cases where the enforcement of the strict letter of the law would be difficult or work a hardship, to modify such provision in the law as will harmonize with its general intent. The New York law provides enforcement by the Borough Tenement House Commissioner, the Borough Fire Commissioner and the Borough Superintendent of Buildings, each acting in his respective capacity, and violations are proceeded against in the same manner and the penalties imposed as are prescribed for like violations of the Building Code.

The Asphalt Industry



A CORNER OF ASPHALT RESEARCH LABORATORY.

EDITOR'S NOTE:—The facts and figures in connection with the asphalt industry were secured in an interview with James L. Rake, a member of the Engineers' Club, who as secretary of the General Asphalt Company has a comprehensive grasp of the entire asphalt situation, both here and abroad.

THE mining, refining, selling and use of natural or native asphalt is an industry in itself, the development of which has reached such magnitude that its ramifications extend to all parts of the world. But it is essentially an American industry, with its administrative center in the City of Philadelphia, and its industrial center at the refineries of Maurer, N. J. The sources of supply are thousands of miles distant.

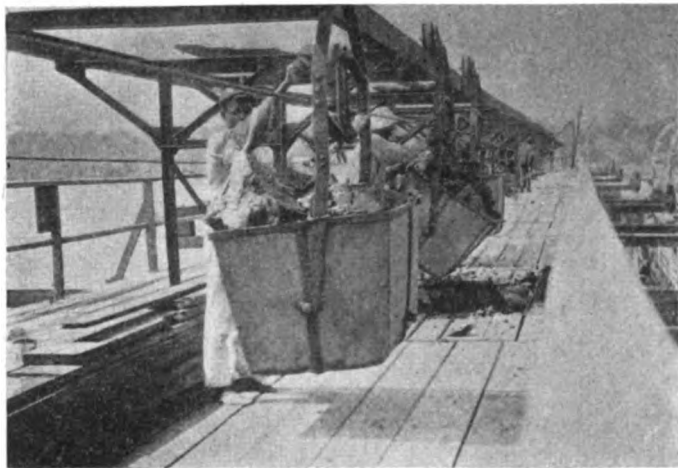
They are the natural asphalt deposits of the Island of Trinidad, B. W. I., and in the state of Bermudez, Venezuela. The words "natural asphalt" are used here to distinguish between a highly specialized industry and that represented by the sale of oil refinery residuums or by-products commonly known as oil or artificial asphalts.

Just previous to the founding of the industry, small quantities of asphalt were exported from Trinidad to



BRIGHTON REFINERY AND TRANSFER ON EDGE OF TRINIDAD ASPHALT LAKE. THE LOADER CARS ARE HERE TRANSFERRED TO THE OVER HEAD CABLEWAY.

Europe, where it was used in the preparation of mastic. Americans had only a superficial knowledge of the material until 1870, when there was laid in front of the city hall at Newark, N. J., the first American asphalt pavement. The honor of being the first to lay such a pavement in the United States belongs to E. J. DeSchmedt, a Belgian chemist, who being familiar with the rock asphalt pavements of Europe, became convinced that asphalt used



DUMPING ASPHALT INTO VESSELS AT PIER END OF CABLEWAY.

as a cement in connection with a graded mineral aggregate would serve as a substitute and as an improvement.

Though rudely constructed the Newark pavement was such a decided improvement upon customary types that the utility and economy of asphalt for street purposes received instant recognition, and thus was begun the asphalt paving industry.

In 1871 a pavement was laid in Battery Park, New York, and in 1873 a section of Fifth Avenue opposite the Worth Monument was paved with asphalt which remained in place until 1886. The successful paving of these streets attracted widespread attention and led to the surfacing of Pennsylvania Avenue, Washington, D. C., with asphalt in 1875. The Avenue from Sixth Street to the Treasury was paved with Trinidad sheet asphalt, amounting to 54,000 square yards. This was the first extensive yardage of asphalt paving in America, and the precedent set by the Capital City was quickly followed by other cities. In 1883 The Barber Asphalt Paving Company was incorporated, and pavements were laid in Buffalo, Baltimore, Philadelphia, Boston, Erie, Omaha, St. Louis, Washington and Louisville, amounting altogether to 353,606 square yards. Ten years later the Barber Company laid in a single year (1893) 1,019,964 square yards. During the previous years the Barber Company and its predecessors had laid a total of 9,758,904 square yards of Trinidad sheet asphalt in more than 38 cities. There were also over a million yards of asphalt blocks in existence, these constructed of limestone aggregate and Trinidad asphalt. The entire area of Trinidad asphalt surface built during its first quarter century as a paving material amounted to more than 14,000,000 square yards.

By leaps and bounds the industry increased with but one notable source of supply, namely, the asphalt lake of Trinidad. With the introduction of Bermudez asphalt from a large deposit in Venezuela, and the extension of asphalt construction to country roads, the industry began to assume its present tremendous proportions. Bermudez asphalt was first used on a large scale in 1892, in Detroit, Mich., and the following year in Washington, D. C. With this start it gained in popularity and is to-day largely employed as a road binder as well as for sheet asphalt paving.

From the two sources of asphalt supply in Trinidad and Venezuela, material has been mined sufficient to build about 200,000,000 square yards of pavements and roads.

Originally the aim of the promoters of the large asphalt companies and combines was to monopolize the production of asphalt and the laying of pavements. These efforts culminated disastrously in the failure of the Asphalt Company of America and the National Asphalt Company in 1901. Two years later the assets of the failed companies were acquired by the General Asphalt Company, of which the principal component parts are The Barber Asphalt Paving Company, as an operating organization, and The New Trinidad Lake Asphalt Company, Ltd., and the New York and Bermudez Company as supply companies. Associated with the General Asphalt Company, there are also several oil companies operating in Trinidad and Venezuela and the company owning and operating the gilsonite mines of Utah. While an efficient contracting organization is maintained, with permanent paving plants in many of the large cities and railroad plants for movement to other places, the company's policy is to encourage



SURFACE OF TRINIDAD LAKE, A SERIES OF GREAT FOLDS, WHERE RAIN WATER GATHERS IN THE CREASES.

the use of natural asphalts by contractors and municipalities generally, rather than to extend its own paving operations. Its volume of paving is therefore steadily decreasing while its sales of asphalt to others correspondingly increases, as does the sale of miscellaneous products in which asphalt is used.

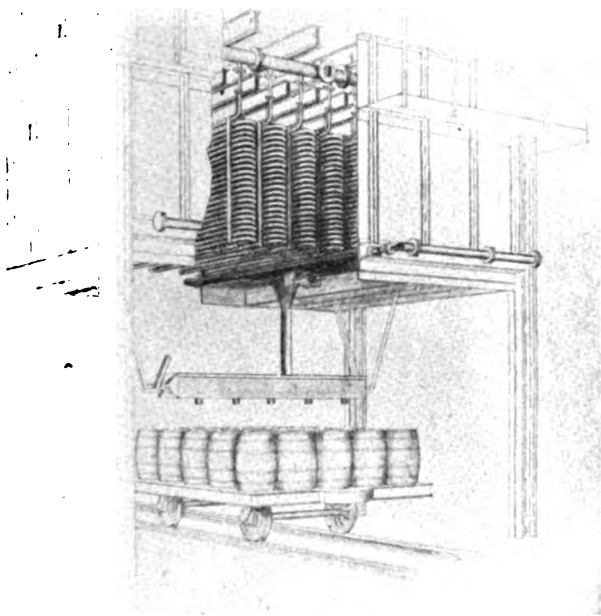
The effort to establish a monopoly in the asphalt industry was abandoned with the disastrous failures of 1901,

THE ASPHALT INDUSTRY

and this effort has not since been renewed. It is mainly due to an open-door policy of the General Asphalt Company that the natural asphalts have become products of common consumption and that the cost of asphalt pave-

tration and mixed-method types was only a small beginning of forms of construction that now consume thousands of tons of asphalt per annum in the form of road binder.

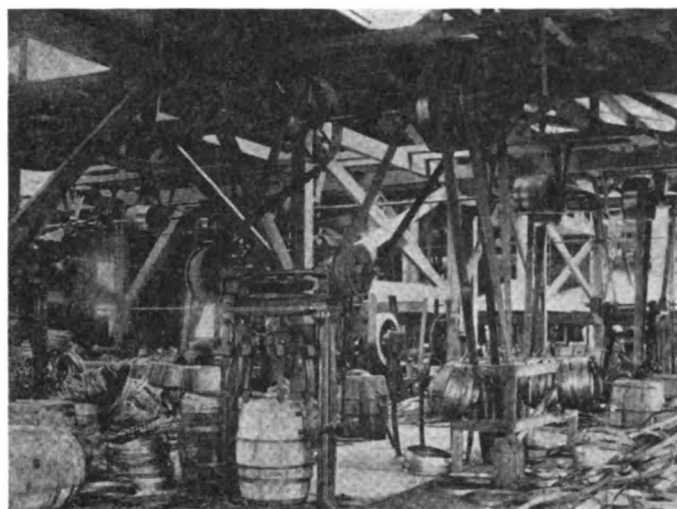
In normal times, and including foreign consumption now largely curtailed as a result of the war, the production of natural asphalts reaches a total of as much as 300,000 tons per annum. According to the United States Geological Survey, the latest figures of which are for the year 1915, the sales of manufactured asphalt obtained from petroleum of domestic origin was in the year stated 664,503 tons. This, however, was not asphalt in the sense that the word is usually employed, for we learn from the same source of information that the output stated included 417,859 tons of material classed as asphaltic oil for road sprinkling or as flux. Nearly one-half of the manufactured bitumen produced from Mexican petroleum is also more properly classed as road oil and flux than as oil asphalt.



REFINING KETTLES, SHOWING ARRANGEMENT OF REFINING STILL FOR NATURAL ASPHALT.

ments has been so largely reduced. Through associated companies and customers the laying of Trinidad pavements has been extended to South America, Canada, England, France, Germany, Austria, Australia and other countries.

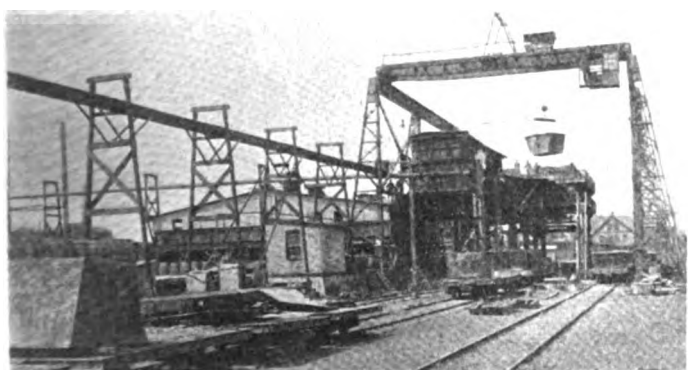
It was about eight years ago that the increase of motor



ONE OF THE MAURER, N. J., ASPHALT BARREL PLANTS SHOWING WHERE 3500 BARRELS CAN BE TURNED OUT EACH WORKING DAY.

The only natural asphalt, properly speaking, produced in any considerable quantity in the United States is the gilsonite mined in Utah. This product is a very hard bitumen totally unlike the lake asphalts commonly employed in street and road construction, but having great value as a component of waterproofing compounds, saturation and coating for ready roofings and in varnish manufacture. To be used in paving gilsonite must be combined with a large proportion of flux to reduce it to a proper consistency. The average gilsonite production of Utah is about 30,000 tons. The other figures in the Geological Survey report referring to the production of "natural asphalt" are misleading for the reason that this term is there applied to bituminous rock containing small percentages of bitumen and which in the nomenclature of the industry are called rock asphalt.

The mining of asphalt at the Trinidad and Venezuela deposits is accomplished by cutting or flaking out the material with mattocks. It is then loaded by hand into

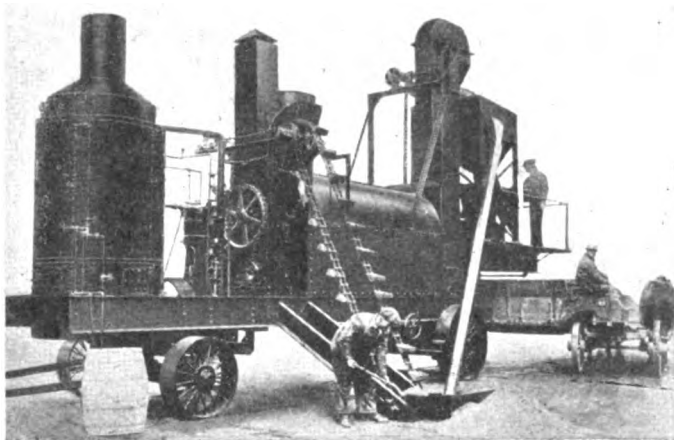


70-TON REFINING STILL, USED IN MAKING BERMUDEZ ROAD ASPHALT BINDER.

traffic led to the demand for something more wear-resisting than plain macadam, and thus brought about a further extension of the asphalt industry. Introduction at the time stated of asphalt-bound roads both of the pene-

cars on light tracks with extra long ties laid on the lake's surface. From the Trinidad deposit the cars are run to a transfer at the edge of the lake and from there conveyed by an overhead cableway to the pier about half a mile distant. The elevation of the cableway at its terminus makes it possible to load ships by gravity. For direct foreign shipment and at times to supplement the United States refineries, a refinery at Brighton, Trinidad, is equipped to produce and barrel 6000 tons of asphalt per day. From the Bermudez deposit the asphalt is conveyed over 7 miles of railway to the loading jetty at Guanoco, on the San Juan River, a small stream emptying into the Gulf of Paria, the body of water which separates Trinidad from the South American mainland.

While the refining of natural asphalt is a simple process consisting of melting the crude asphalt in large steam-coiled stills, driving off the water and removing any foreign matter that the bitumen may contain, extensive plant equipment is nevertheless necessary. The Barber



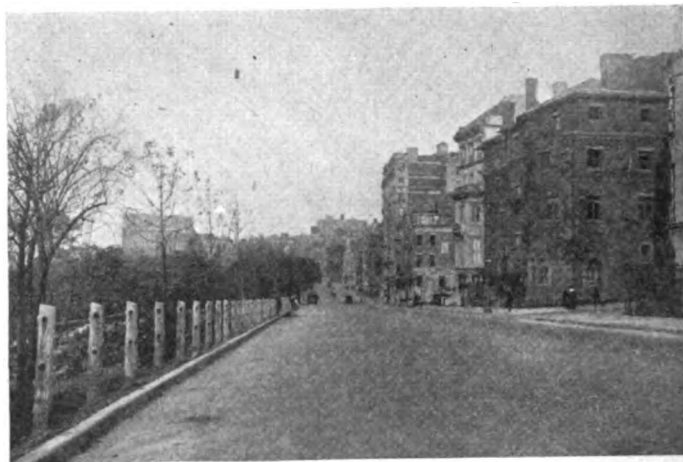
PORTABLE ASPHALT-MIXING PLANT, WITH CAPACITY OF 1000 SQ. YDS. OF ASPHALT TOP PER DAY.

establishment at Maurer, N. J., on an arm of New York Bay, including the sites of both asphalt and oil refineries and manufacturing buildings, covers 186 acres.

A bird's-eye view of the plant shows a network of railway tracks extending from the laboratory building, at the entrance, to the water front and passing on the left the asphalt-block plant, machine shop, 5000 H.P. power house and cold storage conveyor system; mastic plant, four large buildings in which roofing is manufactured; and on the right the manager's office, slack barrel plant and cooper shop. Four tracks continue down to the southern loading and unloading docks, equipped with bridge cranes. Connecting with this system of tracks along the southern boundary of the plant are tracks which circle west and then through the northern side of the site, reaching the northern docks (which are equipped with unloading tower and tracks), the sawmill, wood preserving plants, steam stills, asphalt storage bins, and running under and alongside the elevated stills of the road asphalt plant.

To the Company's docks on what is known as Arthur

Kill River come the steamers bringing crude asphalt and oil from Trinidad, B. W. I., and asphalt from the Bermudez deposits of Venezuela. These are unloaded by hoists which, in connection with railways, deposit the

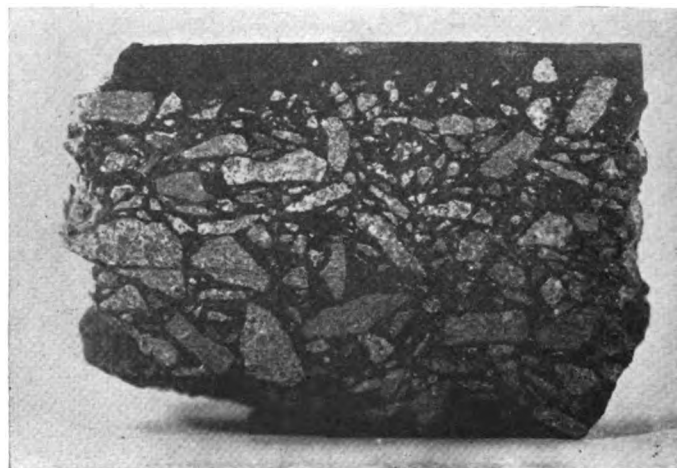


RIVERSIDE DRIVE, NEW YORK CITY. REPRESENTING THE HIGHEST TYPE OF ASPHALTIC CONCRETE PAVEMENT.

crude asphalt at the refining stills or in storage bins. Oil from tank steamers is pumped to storage tanks and refineries located about a quarter of a mile inland, between the tracks of the Central Railroad of New Jersey and the Pennsylvania Railroad.

The location of the plants also facilitates outward water shipments. During a year about 600 vessels, including steamers, sailing vessels, barges, scows and canal-boats, load and unload at the Company's wharf. Three railroads, the Pennsylvania, Central of New Jersey, and Lehigh Valley, are available for the service of the Company's asphalt and oil plants. Two of these have main-track sidings into the plant boundaries.

From the steam-fire and mechanical stills, the road

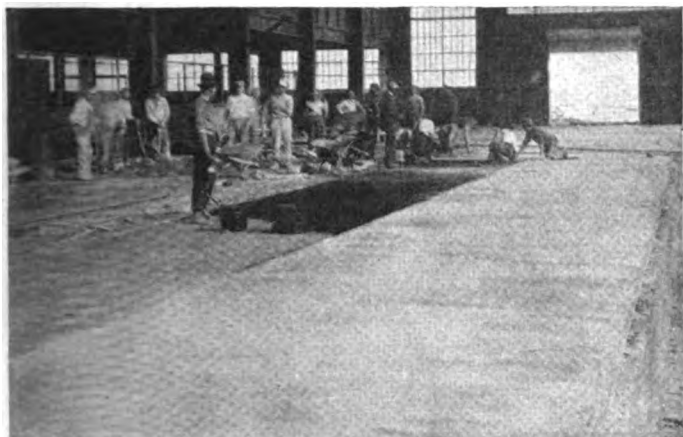


SECTION OF ASPHALTIC CONCRETE PAVEMENT LAID ON VICTORIA EMBANKMENT, LONDON, ENGLAND, 1906. REMOVED, 1915.

asphalt plant, the oil refineries, the asphalt block, mastic and roofing plants, are shipped daily in the busy season about 1600 tons, besides the handling of 200-odd tank-cars and more than 300 flat-cars which crowd the ten miles of

the Company's own railroad tracks within the confines of the plant site. Six locomotives are required for hauling and switching.

Three hundred thousand tons of crude asphalt and 20,000,000 gallons of oil are in round figures the capacity of the combined establishment, so far as the handling of asphalt and crude oil is concerned. In addition to this the ready-roofing plants have a capacity of approximately



LAYING 40,000 SQ. FEET OF ASPHALT MASTIC FLOORING IN HEAVY ENGINE-MANUFACTURING PLANT.

1,000,000 squares, and from the asphalt-block plant are annually turned out about 3,500,000 blocks.

In a single year there have been shipped from the Maurer plants 200,000 barrels of Trinidad refined asphalt, 260,000 barrels of refined Bermudez asphalt, 150,000 barrels of Bermudez road asphalt—an average of 2000 barrels of material per day, exclusive of roofing and miscellaneous shipments.

To provide barrels for these shipments is in itself a task of large proportions. Formerly, thousands of barrels were bought annually, but to secure a better package for refined asphalt and asphaltic compounds a slack barrel plant was erected at the asphalt refinery and a tight barrel plant at the oil refinery, in which plants are now manufactured barrels for all materials.

Close control of the operations of the Maurer plant is exercised by the laboratory, occupying a separate building consisting of two floors and a basement, fully equipped with the necessary apparatus for physical and mechanical tests pertaining to the industry. The laboratory employs a force of 28 under the supervision of the chief chemist.

The duties of the laboratory in connection with the operation of the plant include the inspection of all raw materials received, the design of formulas for the use of such raw materials in the manufacture of finished products, the inspection and testing of these products during the process of manufacture and when finished, in order to make certain that materials comply with specifications. The laboratory is also employed in the inspection and testing of plant supplies.

In addition to the duties just outlined, a part of the

laboratory force is engaged in research work with a view to improving and expanding the employment of asphaltic products.

It is hardly necessary in an engineering publication to describe the principal forms of asphalt street and highway construction. Comment may, however, be made on some recent developments in the industry. The October, 1916, number of the Proceedings of the Engineers' Club of Philadelphia contained an article on the "Latest Advance in the Technology of Asphalt Paving," which described the results of Mr. Clifford Richardson's colloidal investigations with reference to their application to asphalt paving mixtures. Other practical developments are the hardening of cements now used for heavy traffic streets, which have been reduced, generally speaking, from 55 to 65 penetration to 30 penetration on streets of the heaviest traffic; and the tendency to increase the thickness of the binder course to overcome the tendency toward shoving that is manifested by some asphalt pavements under heavy motor traffic. This practice has not been generally adopted but it is believed that experience will show the wisdom of a reportioning of the binder course and wearing surface of sheet asphalt surfaces. We are likely to see an increasing number of pavements in which the binder course is, say 2 inches and the wearing surface $1\frac{1}{2}$ inches.

One of the most noteworthy examples of the stabilizing effect of a moderately close binder course is afforded by the Trinidad pavement on the Thames-Victoria Embankment, London. In that pavement there was used a



MUNICIPAL ASPHALT PAVING PLANT, DETROIT, MICHIGAN.

binder course of 3 inches with a wearing surface $1\frac{1}{2}$ inches thick. This pavement has given excellent service for ten years under the exceptionally heavy traffic of the Embankment, and no tendency toward shoving or waving has been apparent at any time.

Another striking development of the industry is the popularity of so-called asphaltic concrete pavements as distinguished from sheet asphalt, the wearing surface of

which does not ordinarily contain any sand larger than that passing a 10-mesh screen. Asphaltic concrete is a one-course pavement and to the fine aggregate of the sheet asphalt mixture there is added 30 per cent or less of small stone chips not exceeding $\frac{1}{2}$ inch in size. At their best pavements of this type closely approximate sheet asphalt mixtures with respect to the amount of very fine mineral aggregate—filler. Among other noteworthy examples of this form of construction that might be instanced is Riverside Drive, New York. The proportions of the mixture on this heavy traffic thoroughfare are as follows:

		A	B
Asphalt cement	110 lb.	8.9	11.1
Portland cement dust	110 lb.	11.9	16.5
Sand	312 lb.	14.5	20.1
Stone screenings	564 lb.	18.6	25.9
		10 mesh	18.9
		4 mesh	19.1
		2 mesh	8.1
	1,096 lb.	100.0	100.0

Column "A" gives the average composition of the surface mixture as laid on the street; column "B" that of

the finer portion excluding the quarter-inch and half-inch stone.

While the term asphaltic concrete is used to "cover a multitude of sins," including many pavements which are more properly classified as asphalt macadam, there is no doubt that single-course stone, sand and asphalt pavements will be used to an increasing extent on all except the heaviest traffic thoroughfares. The yardage of such pavements, which have only been used to any considerable extent in the last four or five years, awarded in 1916 for use in connection with Trinidad and Bermudez asphalts alone exceeds 6,500,000. In this connection perhaps it should be pointed out that the so-called Topeka specification for asphaltic concrete was based upon the decision of the U. S. district court of Kansas, which did not pretend to determine what was a desirable paving specification; it simply held that a certain grading of aggregate did not infringe a patented pavement. Thereupon a number of communities proceeded to lay pavements in accordance with a formula in behalf of which little more could be said than that it was not an infringement. In the past four years, however, Topeka pavement has gone through an evolution in which it has lost its name



TRANS-SHIPING STATION FOR BERMUDEZ ASPHALT AT GUANOCO, VENEZUELA. NOTE NATIVE VILLAGE IN THE BACKGROUND.

and most of its other characteristics and become asphaltic concrete, which as stated is good in proportion to the closeness with which the finer parts of the aggregate approximate those of a high-class sheet asphalt mixture.

Both terms, asphalt macadam and asphaltic concrete, are used interchangeably, but the former term can only be properly applied to mixtures which consist of say from 10 to 15 per cent of sand, the remainder of the aggregate being stone not larger than $1\frac{1}{4}$ inches and not smaller than $\frac{1}{2}$ inch. It is extremely desirable that there should be more care used in the employment of the terms asphalt macadam and asphaltic concrete.

In the early days of the industry the only plants available were large stationary installations located mainly in cities of considerable size; and railroad plants. The extension of asphalt construction into rural districts has led to the design of a number of excellent portable plants which can be moved from place to place and located economically both as to the site of the construction to be done and the handling of the materials. One such type of plant is herewith illustrated. It has, according to the size of the heating drums, a capacity of from 800 square yards of 2-inch paving per day upward.

In addition to what may be termed forms of permanent construction, liquid or fluxed asphalt is now largely utilized for the building of so-called carpet coats, which should be distinguished from road oiling. A carpet coat properly constructed with stable materials is a form of asphaltic concrete in a very thin layer. Ordinarily less than $\frac{1}{2}$ gallon of asphalt per yard is applied either hot or cold and covered with stone chips. Such a surface, however, can only be successfully constructed on a base that can be cleaned, such, for example, as that of a macadam or concrete road.

Aside from the paving industry, which will, of course, be the one direction in which the larger tonnage of asphalt is absorbed, it is used in increasing quantities in a score of other industries. An enormous quantity of asphalt is used to saturate felts in the making of materials for built-up roofs, ready roofing and asphalt shingles. A few other products made from asphalt or asphaltic compounds are waterproofing fabrics, paints, asphalt putty, caulking pitch, tile cement, varnish, pipe coatings, marine paint, mastic, and "mineral rubber" a material largely used in the compounding of rubber goods.

FOREIGN NOTES

JAPANESE SHIPPING AND SOUTH AMERICA

We read in the *London and China Telegraph* that a Japanese commission, representing a group of Japanese capitalists, manufacturers and merchants, is at present in Brazil making a study of the economic and commercial conditions in Rio de Janeiro, Sao Paulo, Parana, Santa Catharina, and Rio Grande do Sul, with a view to the possibility of establishing steamship service between Japan and Brazil *via* Singapore, Ceylon, Madagascar and Cape of Good Hope.—*Engineering*.

NEW NITROGEN WORKS

A new company with a large capital has been formed for the manufacture of nitric acid and other chemical products in Sweden. It has entered upon a contract with the Royal Waterfalls Board for the supply of electric energy, 12,000 kw., from the Trollhättan power station, and the works will be erected on the area reserved for industrial installation at Trollhättan. The annual capacity will be some 7000 tons concentrated nitric acid, with nitrates as an auxiliary product. The new company will adopt the Birkeland-Eyde method, for which rights have been secured for Sweden. The work is being pushed ahead with all speed, and the works are guaranteed to be ready this year. The Swedish explosives industry and the large Grängesberg mining company are represented on the board.—*Engineering*.

MORE CHINESE RAILWAYS

The Chinese Government has placed contracts with the Siems Carey Company, of St. Paul, Minnesota, for the construction of more than 2000 miles of railways in China. The Siems Carey Company is financed by the American International Corporation, of New York.—*Engineering*.

EVERY-DAY USES OF PORTLAND CEMENT

We notice that the Association of Portland Cement Manufacturers, 1900, Ltd., Great Britain, have issued a book, entitled "Every-day Uses of Portland Cement," in which are given the following colours to be used with cement:—Red: 86 parts cement, 14 parts red oxide of iron. Yellow: (1) 88 parts cement, 12 parts yellow ochre; (2) 90 parts cement, 10 barium chromate. Blue: 86 parts cement, 14 ultramarine. Green: 90 parts cement, 10 parts oxide chromium. Chocolate: 88 parts cement, 6 parts black oxide manganese, 4 parts red oxide of iron, 2 parts black oxide iron or copper. Black: 90 parts cement, 10 parts black oxide manganese or carbon black. White: 67 parts cement, 33 parts powdered chalk or barytes. Pink: 97 parts cement, 3 parts crimson lake. Mix the colours dry with very fine ground cement, whether to be used neat, with sand, or to be converted into concrete.—*Indian Engineering*.

(Continued on page 46)

Oral Engineering at the Front

By DR. CLARK J. HOLLISTER *

WHEN Company "B" Engineer Corps was ordered to the Mexican Border, I experienced considerable regret that I was no longer a member of the Company and started away on my vacation at the Delaware Water Gap, wishing that I was seeing real military service with the "boys" at the front.

The old saying that if you wish hard enough things are sure to come true must have applied in my case, because I had hardly become settled at the Gap when I was called on the long distance 'phone and asked if I cared to go to El Paso, Texas, to do dental work for "Our Boys."

My answer may be surmised by the fact that I was in Philadelphia the following morning, and on my way to the border within a week.

It appears that Capt. B. C. Tilghman, on General Clement's staff, wrote to friends in the city telling of the suffering of the men in ranks with "tooth troubles," and that there was no way for them to get relief, as the Militia Dental Corps, then being organized, would not be ready for service for quite some time, and asked if some of the organizations interested in the welfare of the Pennsylvania troops would not equip and send some one immediately.

Mrs. George W. Childs Drexel, President of the Pennsylvania Women's Division for National Preparedness, upon hearing of the suffering of the soldiers from toothache, said she would gladly equip and send a dentist for two months.

Fortunately for me, my name was suggested and I was directed to report for duty at Camp Stewart, about nine miles outside of El Paso, where the Pennsylvania State Troops were encamped.

When I arrived, I "fussed" around for a day or two trying to locate a tent in which to work, after which, finding that I was not making any real headway, I took the "bull by the horns" and set up my chair in the open.

For a week my work was necessarily confined to temporary relief work, after which I was supplied with an "office" in the form of a 14 x 14 tent, equipped with a flooring, shelves, table and desk for instruments and record books, all of which effectively answered the purpose. A member of the hospital corps assisted me, and the Drum Major of the Third Pennsylvania Infantry Band appointed himself my chief clerk and bookkeeper.

At first, I was looked upon with suspicion by the boys, some of whom were overheard to remark, "that they would steer clear of that butcher shop," but tooth troubles soon brought a few of them to my "office," and when they

learned I was there to help them and not just to pull teeth, their fear turned to confidence, and from that time on I was easily the busiest man in camp.

I started the day's work at "sick call" (6.30 A.M.) and on account of the great number of men seeking relief, I was kept at the chair until five o'clock, with only a few minutes off for noon "mess." The lowest number of patients in one day was 37 and the highest 58. These figures do not include the patients for "oil-of-cloves" treatment or treatments after extraction. My work was constructive rather than temporary. Wherever possible, I saved, treated and filled teeth; but when they had gone too far to save, I extracted.

To you, it may seem almost unbelievable that so many people have never been taught the value of oral hygiene. My experience in this work showed me that there is a great work to be done in educating the general public in the proper care of the teeth and mouth, and, as soon as this work is started, we will have discovered a way to lessen the number of patients and prisoners in our public institutions. The causes of inherited tendency to crime and physical abnormality have been attributed to many different things, but now we are beginning to realize that the teeth and mouth have a great deal more to do with the general health than was believed in the past.

In each day's work many amusing and pathetic things happened. As each patient sat in my chair, I asked him if he took any care of his teeth, and in almost all cases was told that he never cleaned his teeth. The army requires that each soldier shall have a tooth-brush in his kit. I learned that the boys were using these tooth-brushes as gun cleaners, for the officers inspected the guns often, and thoroughly, but did not examine the teeth so closely. This fact told me at once that my work and duty toward these boys was not just to relieve pain, but, at the same time, to try to teach them why and how they should take care of their mouths.

About six years ago, a boy about eighteen years old, came to my office in Philadelphia, suffering with toothache. The boy operated an elevator in a men's clothing house, and was trying to support his mother on a salary of \$6 per week. He had been referred to me by the proprietor of the store, a patient of mine.

I learned that he had never been taught to take care of his teeth, so I began with the very elements of hygiene, giving him a tooth-brush and powder with instructions as to their use.

It took me nearly six months to complete the necessary dental work, and he paid me at the rate of 50 cents per

* Member of the Engineers' Club.

ORAL ENGINEERING AT THE FRONT

week. In this particular instance, I would have liked to have done the work gratis, but I have learned that the poor appreciate dental service more when they have to pay for it. This poor fellow was paying the bill for over two years; for frequently he had to pass his weekly payment, but he always came and explained why he could not spare the money. He took special pride in the appearance of his teeth and was very appreciative. His em-



OFFICE AT CAMP STEWART.

ployer later told me that the dental work had saved the boy's position, for his former appearance had been so disgusting that his contact with customers was undesirable.

After a few years I left Philadelphia and was gone for about two years, so lost track of the boy. When I went to the border, I worked in civilian clothes the first few days. I went to El Paso on the late train to spend my first night in camp. I was halted by the sentry, who, of course, did not know me; so I was held for about an hour before I was recognized and allowed to pass. The next night I "ran the guard," which means that I slipped by unseen by the sentry. The next night, I wasn't so fortunate, for as I crossed the guard line, I was startled by a sharp command of "Halt." I stopped and the sentry, with a showing of good training, asked, "Who is there?" I replied, "Friend." He said, "Advance Friend to be recognized." I told him that I was a civilian dentist, who was living at the camp; and before I would explain any further, the sentry almost shouted, "Hello, Doc, you don't know me, do you?" I struck a match and saw my boy patient of years ago. He had heard that I was in camp, but owing to military duties, had not been able to see me. He passed me through, and I asked him to see me at my "office" in the morning.

In the morning he called, and the first thing he did was to show his teeth, and say, "How do they look, Doc?" It brought a smile of satisfaction to my face for two reasons: first, that the pride I had created in him years before had grown instead of being forgotten, and secondly, because his teeth showed they had received good care.

This case only shows what can be done among all classes, if the government or charitable organizations will

only supply competent and sincere dentists to teach and work in the schools and homes of the working classes.

The patient spoken of in the foregoing instance is still employed by the same concern as a very efficient salesman, now making from \$25 to \$30 per week, so instead of losing a \$6 "per" job, he has advanced far beyond anything he ever dreamed of because of proper dental service.

My operating tent was next to the hospital, and for a little diversion I would go there occasionally to look over the cases. A fellow of Russian birth, who seemed to be there more than anyone else, interested me, and an examination of his teeth showed them to be in the worst condition possible. I advised him to let me take out the bad ones and clean the remaining ones. He refused to permit me to look into his mouth again, after I suggested extracting. I talked and reasoned with him, trying to make clear that his illness was occasioned by the bad condition of his mouth, but in vain.

I argued that if he did not permit me to make the extractions, that some night they would cause him pain, and it would be necessary for him to come to my tent for relief.

As predicted, two nights later at 2 A.M., I heard a tapping on the pole of my tent; and this being the usual manner of calling me during the night, I arose, donned my bathrobe (a luxury for camp life), lighted my oil lantern, and went forth and found my Russian friend with one side of his face swollen to twice its natural size. I sternly asked him how long his teeth had ached, and he replied, "Since the day before." I told him if he had been able to stand it that long, he could wait until morning, so saying "good-night," turned to go back to bed. My visitor cried that he simply could not stand it any longer.



EMERGENCY RELIEF WORK WHILE ON THE MARCH.

My reason for treating him in this manner was to impress upon his mind that having his teeth fixed was for his own good, and not practice for me, as he thought.

After worrying him for a few minutes, I took him down to my "office tent" to try to relieve him. I aroused one of the sleeping medical officers to hold the lantern for me while I operated. The light was useless, so I extracted with elevators in the dark. It was necessary to send for

his Captain the next day to induce the man to open his mouth, but his fear soon turned to confidence, and after two weeks of short daily sittings, my patient began to show more interest in life. His Captain later reported that he seemed interested in drills and various other military duties, and before his regiment left for home, I had the satisfaction of seeing him transformed from an unhealthy, unruly, inefficient soldier to a bright, willing, efficient man. This, with many other cases of similar nature, proves most forcibly the saying that "an army fights or trains on its stomach," and the majority of people are beginning to realize that if the teeth are in bad condition, the general health cannot be good.

The entire Seventh Division was ordered to go on a four-day hike, and, at the request of Col. Geo. Kemp, of the Third Pennsylvania Infantry, I was supplied with a horse, and my equipment, composed of folding chair, foot engine, and a student's case for instruments, was packed in one of the hospital wagons, and I went along with the



AT WORK ON THE HIKE.

troops. In my saddle bags, I carried instruments and medicines for emergency work.

The division, made up complete, as in actual war conditions, left Camp Stewart at 8 A.M. on Monday, September 25. The first day's march took us through El Paso and into the valley of the Rio Grande. Things went along very smoothly during the day as the boys were fresh and we were able to get plenty of water. I had very little to do until the halt for the night. We camped on the banks of the Rio Grande, and fifteen minutes after the men broke ranks, the shallow muddy river resembled Atlantic City's most crowded beach. It was an amusing sight to see at least 9000 men romping in the water; but it was most refreshing after the long march over hot dusty roads.

When my chair had been set up, I was called upon to make some extractions and temporarily relieve exposures. This kept me busy until about 10 P.M., when I rolled up in my blanket, with the sky for a roof, to get a much-needed sleep, greatly fatigued, as you may imagine, being unused to horseback riding.

During this night, as on the other nights, we were away from camp, I was up most of the time relieving abscesses and stopping toothaches. The second day proved to be the most severe for the men on foot. They suffered much from blistered feet and lack of water. Camp was pitched at 4 o'clock in the afternoon, but owing to the fact that the supply wagon trains were stalled in the sand, the tired and hungry boys did not get anything to eat until long past midnight. Conditions during the last two days of our march were the same, so that when the tents at Camp Stewart were sighted they looked almost as good as "Home Sweet Home."

Notwithstanding the fact that I was tired and dusty, I was genuinely glad I had gone along, for it was the first time in the history of the country that a dentist equipped for work went with an army marching under war conditions.

The time is near at hand when our country will realize the importance of good teeth to the soldier, for if a man is suffering with his teeth, he cannot be an efficient fighting unit.

In the militia of this state (Pennsylvania) I found that at least 90 per cent of the men in the ranks were in need of immediate dental attention.

There is a Militia Dental Corps which has just been formed. The dentist is given a rank of First Lieutenant with the pay of that rank in the regular army (\$166.67 per month). When I left the border there were eight dentists with the Pennsylvania troops, but at that time the government had not supplied them with an equipment with which to work, so it fell to me to try to relieve all of our 13,000 boys.

The soldiers for whom I work endeavored to show their appreciation of what I had done for them in many ways. One poor fellow, whose pay was \$15 a month, gave me a \$3 picture, and I was kept supplied with tobacco and fruit by my patients, and coming from "light" pocket-books as did these gifts, showed me that this bit of practical charity was much appreciated by those served.

Too much credit cannot be given to those who made this work possible. The good work will undoubtedly reflect for many years to come.

No machine, no matter how wonderfully constructed, can do good work unless it be properly adjusted and cared for. The human machine is no exception to this rule. A good digestion is half the battle, sharing in importance the quantity and quality of the food supplied. Most of the great industrial establishments have recognized the effectiveness of supplying medical attendance for their employes, and in this connection, I have no hesitancy in predicting that in the near future the wisdom of supplying dental service will also be properly considered. The general adoption of this policy will be more than repaid by the increased efficiency, which comes when employes are kept physically fit to attend to their duties.

Telephone Engineering

PAPERS BY JUNIOR MEMBERS ENGINEERS' CLUB OF PHILADELPHIA

"Present Worth" Methods

As Applied to Telephone Engineering Studies

By A. P. GODSHO

THE necessity of having to deal with a multitude of small units of various degrees of distribution is a characteristic of any problem or study in telephone engineering. In a particular exchange, for instance, we have the case of a multiple switchboard with a great number of jacks in a small space, and, on the other hand, in a particular exchange area the wide dissemination of subscribers' stations. Due to this distinguishing feature of all kinds and forms of telephone equipment, telephone engineering confronts us with problems entirely distinct from the technical side. These may be easily solved tech-

once? Or, is it more economical to construct ducts at the present time or several years later?

As a general rule, in the study of two or more technically correct plans we may state that we have always two economic problems to solve, namely, the choosing of the most economical plan satisfying a given condition, and then the determination of the most desirable time from an economical standpoint to put that particular plan in operation.

A study to determine the most economical plan, or the most economical time, or both, must include these items: New plant, present plant, and salvage on discarded plant. We note right here that "new plant" may not have to be provided for immediately, but it may be required after a lapse of time, and further the salvage of "discarded plant" may not be available for some time.

A comparison of immediately required capital cash outlays, as a basis of economy, is misleading. The plan costing more money initially appears often at a disadvantage, although it may be more cheaply maintained, and its longer life may compensate for the larger outlay so that in short it may be the cheaper plan after all. In other words, the direct cost method is of but little value.

The "annual charge" method cannot be regarded as conclusive either, because it does not take into account a change of charges (decrease or increase) before the time of a change is actually at hand. Figure 1 illustrates this case:

Here we have "annual charges" for plan A less than those for B, for 5 years; thereafter, the charges for A are greater than for B. The problem of making the proper allowance for a change in annual charges, etc., at a deferred time is taken care of by the "present worth" method.

For example: \$10,000 is to be expended 10 years in the future. To have \$10,000 available then it will be only necessary to have on hand now a sum, which at the rate of say 6 per cent interest, will amount to \$10,000, that is only \$5580 will be required at the present time. Therefore, the "present worth" of \$10,000 deferred 10 years is \$5580. The "present worth" of \$1 for various periods at 6 per cent is shown in Figure 2.

Similarly—if a sum of \$1000 must be expended yearly to meet charges on a definite kind of plant for a period of 10 years: at the rate of 6 per cent interest per annum it

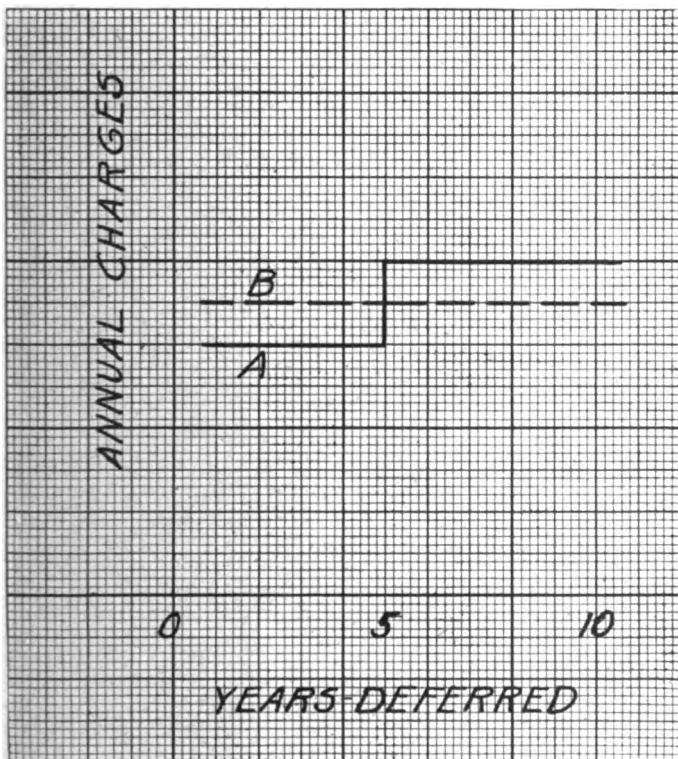


FIGURE 1

nically to our entire satisfaction and still be of doubtful value as soon as the economic aspect is considered. The economic factor shows up prominently when problems like the following confront us:

In a duct run, is it economical to place 4 ducts immediately and 4 ducts later, or should 8 ducts be placed at

will be necessary to invest \$7,360, and not \$10,000 to cover the yearly charge of \$1,000 for 10 years. By reason of the charges being deferred successively for longer periods of time, there is, for example, need only of \$592 to be reserved for the ninth year's charge of \$1000. Therefore again, the "present worth" of an annual charge of \$1000 for a 10 years' period is \$7360. The "present

by the requirements, as in each case 1200 pairs are available at the end of the period.

The theoretical ideal period is a variable, the least common multiple of the natural periods of life of the different units involved in the study, ranging from 50 to 100 years. As it is not possible to predict our requirements so far ahead the period selected is often based on the natural life of the most costly unit of the study.

In most cases the charges as a rule group themselves into capital and upkeep charges. If the unit of the study lives its natural life in meeting the requirements capital charges are carried; if not, the original cost is carried in lieu of the capital charges, and salvage is allowed.

Some of the many points that come up continually in a "present worth" study will be illustrated by the following example.

Suppose that along a certain pole line we require 200 cable pairs for subscriber purposes within 12 years. At the end of that time it will be necessary to place conduit due to ordinance regulations. The question is—shall a 200-pair cable be placed immediately, or shall a 100-pair cable be placed at first, and then a second 100-pair cable

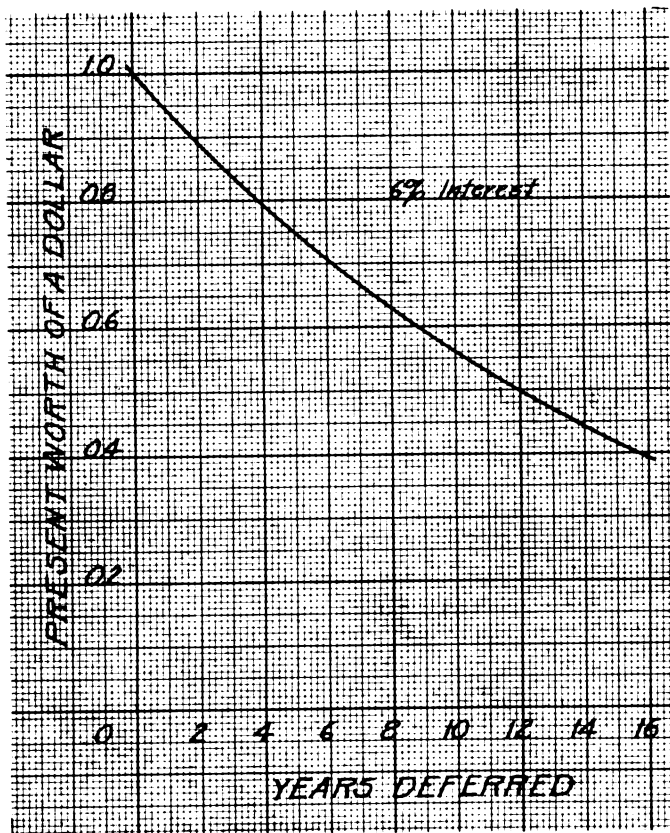


FIGURE 2

worth" of an annual charge of \$1 for various periods at 6 per cent is shown in Figure 3.

Though an obvious fact apparently, it cannot be too strongly emphasized that the "present worth" method does not give "actual costs." It serves, however, as a reliable method of comparison because it supplies a basis upon which the actual economic aspect rests. Needless to say all plans must first be brought to a basis of equivalent facilities. It is essential that the various charges be accurately known before the "present worth" method is applied to any problem.

Making a "present worth study" we first select a time period and then proceed to lay out a number of different plans based on an equivalency of facilities at the end of the study. The term "facilities" is used to denote the number of units of a certain kind, which are provided to meet the specified requirements. If, for instance, we have a 600-pair cable at present, and we require 600 pair additional within a certain time, one plan will provide these by two 300-pair cables, the other by one 600-pair cable. Both plans, however, are equivalent as demanded

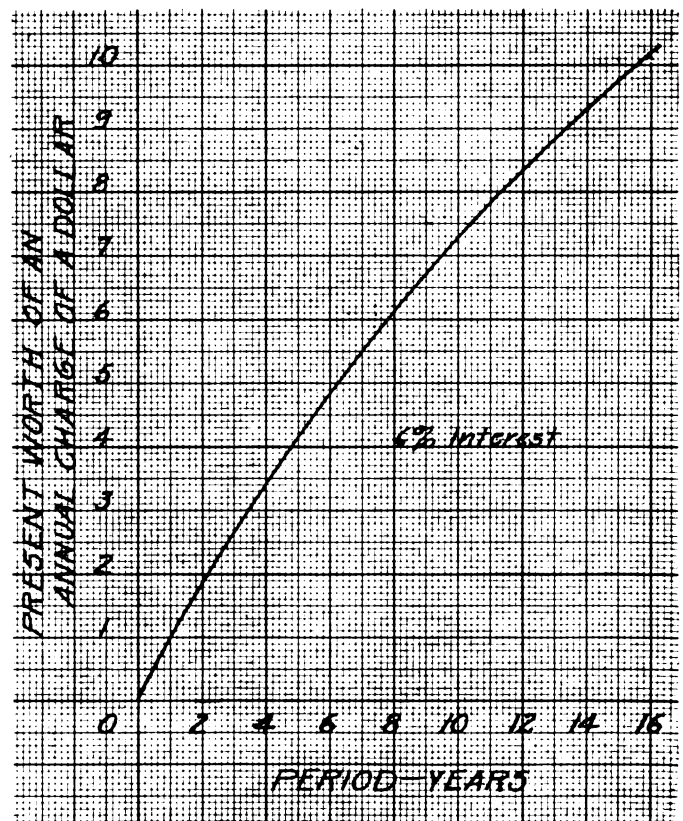


FIGURE 3

6 years from now (assuming a straight line growth in requirements). The natural life of an aerial cable is 12 years and at the end of its life it has a junk value of 30 per cent of the original cost. Computed on this basis the rate of depreciation (compounded) is 4.2 per cent. Interest will be taken as 6 per cent and maintenance as 4 per cent.

TELEPHONE ENGINEERING

PLAN I—1 200-PAIR CABLE

This may be handled in either of two ways, mathematically equivalent as follows:

(a)	Cost	Annual Charge	P. W. of Costs
Cost of 200-pair cable.....	2800	...	...
Annual charges—14.2 per cent.....		397	...
Present worth—12 years. Factor = 8.38		...	3320
(b)			
Cost of 200-pair cable.....	2800	...	2800
Maintenance—4 per cent.....		112	...
Present worth—12 years. Factor = 8.38		...	938
Gross Total			3738
Salvage—30 per cent of cost.....	840	...	...
Present worth—deferred 12 years Factor = 0.497		...	418
Net Total			3320

PLAN II { 1 100-PAIR CABLE NOW 1 100-PAIR CABLE IN 6 YEARS

	Cost	Annual Charge	P. W. of Costs
Cost of first 100-pair cable.....	1900	...	...
Annual charges—14.2 per cent		269	...
Present worth—12 years. Factor = 8.38		...	2240
Cost of second 100-pair cable	1900	...	...
Present worth—deferred 6 years.			

	Cost	Annual Charge	P. W. of Costs
Factor = 0.705	...	...	1340
Maintenance 4.0 per cent.....		76	....
Present worth—6 years, deferred 6 years. Factor (12 years = 8.38)–(6 years = 4.92) = 3.46.....		...	263
Gross Total			3843
Salvage second cable—30 per cent cost	570	...	....
Present worth—deferred 12 years. Factor = 0.497		...	284
Net Total			3539

The study just made shows that Plan I is the more economical, and should be the one adopted. In Plan II the second cable could have been handled on the "annual charge" basis also, if the rate of depreciation corresponding to a 6-year life and 30 per cent salvage had been computed. Inasmuch as it is inconvenient to do this, annual charges (with the true depreciation percentage) are considered only in case the cable lives its natural life in the study period, or beyond. An "actual cost" or "annual charge" comparison would have made Plan II appear the more economical.

"Present worth" methods are widely used, not only in purely engineering lines, but also in appraisal and insurance computations.

Those who are interested in the mathematical aspects of the "present worth" studies are referred to Trans. A. S. C. E. vol. lxiv, p. 18.

The Traffic Department of a Telephone Company

By A. L. GRACEY

THE business of furnishing telephone service to the public has in the last twenty years grown to include so many phases of engineering that any one of a great number of divisions would furnish abundant material for a paper.

The Telephone Company consists of the following departments: Auditing, Commercial, Engineering, Plant and Traffic; the general functions of which are fairly obvious. It has but one line of goods for sale, viz., service. The entire investment in telephone plant and all running expenses are for the purpose of handling the telephone traffic of its subscribers, and from this service is derived the total revenue of the Company. The responsibility for handling this traffic devolves upon the Traffic Department, and under the present method of organization, approximately one-half the employees of the Telephone Company are members of this Department.

In general, the Traffic Department may be divided into two classes—the Traffic Engineering and the Traffic Operating Departments, the latter constituting the larger division. The Traffic Engineering Department shares with the Engineering Department the responsibility for engineering all telephone switchboards, toll lines and mis-

cellaneous operating equipment. The Traffic Operating Department is responsible for making use of all operating equipment to render the highest possible grade of service to the public.

In the office of the Traffic Engineer, there must be kept accurate records of all switchboards in the territory, with regard to the type, amount and period for which they will last. The growth in each office must be carefully watched and recommendation for new or additional equipment made a sufficient length of time in advance, to permit of the installation in time to meet the demands of increased traffic.

Assuming that a good grade of service must *always* be rendered, traffic engineering is a question of dollars and cents. Accordingly, the basis upon which new equipment is recommended should take into account the following questions: First, "Is it necessary to spend money for new switchboard?"; second, "Why should the money be spent at this time?"; and, third, "Why is the type of switchboard recommended, the most efficient and economical?" In order to answer these questions satisfactorily, it is evident that there must be some intelligent basis upon which to work. It is obviously necessary that something

be known of the amount of work to be performed in the operation of a given switchboard. For this reason records are kept continuously of the number and class of calls made in most offices. Some calls are from flat rate subscribers, involving no ticketing whatever; some are from measured service subscribers on which a ticket must be written or a register operated; some are from party line subscribers on which the operator must ask for the letter; some are from coin box stations requiring that the operator collect the amount of the call. Some of these calls go to subscribers in the same office requiring one operator to complete the connection; some go to subscribers in nearby offices requiring two operators to complete the connection; some go to subscribers in suburban offices requiring what is known as the tandem method of operation, which involves three operators; some are for subscribers in out-of-town offices requiring the toll-board method of operation, involving the recording operators, messengers, line operators, etc.; some calls are for information; some for the sending of telegrams; some are emergency calls requiring the utmost speed in handling. These are some examples of the various kinds of calls that the operator must handle. Each one of these calls can be reduced to the terms of a unit which has been selected as the amount of work necessary to complete a call from a flat rate subscriber to another subscriber in the same office. This kind of call has been selected because it is the simplest and as a rule the most frequent kind of call which the operator handles. In this way the number of calls as determined from the continuous records is reduced to units and a basis formed for computing the operating labor performed. There has been chosen a standard number of units based on stopwatch observation that an operator is expected to perform in an hour. The busiest hour of the day is then selected and by the method described, the number of switchboard positions required is calculated.

The number of calls handled bears a certain relation to the number of subscribers working in the central office. This relation is established from records for two or three years back, and, using a careful forecast of the number of subscribers expected at some future date, an estimate can be made of the number and character of calls expected at that time. From this can be calculated the number of switchboard positions necessary to handle the estimated traffic.

By using this method the necessity for a new switchboard can be expressed in definite terms and the date on which it is required can also be determined definitely. The reasons that enter into the selection of certain types of switchboard in preference to other types can hardly be discussed here, except to say that the amount and character of the traffic must be carefully analyzed and the type selected which will permit of rendering most efficiently and economically, a high grade of service.

Toll and trunk lines are engineered on much the same basis as switchboard equipment. Trunk lines might be designated as those connecting offices in a multi-office exchange such as Philadelphia, while toll lines would be

those which connect more distant offices. As in the case of switchboards continuous records are kept of the amount of traffic handled on each trunk group. For economic reasons it is not practical to provide trunk facilities on as liberal a basis between distant offices as between nearby offices, consequently each of these two kinds is engineered on a different basis. *Trunk* lines are provided in sufficient number between two offices that during the busiest hour of the day, there is no delay in the passing of a call. A large number of factors must be considered in connection with *toll* lines.

The capacity of a line or a group of lines is determined by the average holding time per call and the number of calls to be handled in a given time. The holding time is made up of the time of conversation plus the use of the line for operating purposes. The number of calls that can be handled per line increases with the number of lines in a group. All these conditions have been studied and reduced to known quantities and put in the form of curves. Knowing the rate of increase for two or three years back, and considering all conditions of business and company policy, the traffic can be estimated for several years in advance and additional trunk and toll lines recommended to care for that traffic.

Having seen the importance of the traffic data and how the spending of large sums of money is based on what is found from this data, it can be readily seen that every possible precaution should be taken, and is taken, to make it reliable and accurate.

As already mentioned, it is the job of the Traffic Operating man to take the equipment given him by the Traffic Engineer and give the public a high grade of service. In a business where the demand varies throughout all hours of the day, the question of organization is an important one, in fact the most important with which the operating man has to deal. This involves the proper distribution of the traffic to be handled and the selection of sufficient operators in order that a central office may work at its highest operating efficiency. The ideal arrangement is to have enough operators to go on or off to make the operating force just equal at all times to the theoretical load. Three or four times a year in the large offices an organization study must be made in order that there may be available a sufficient force of operators to handle the traffic as it increases. It must be borne in mind that it takes an average of a year's time for an operator to reach an average grade of efficiency. This makes it imperative that organization studies be made a sufficient length of time in advance of actual requirements to enable the traffic operating man to engage and train the number of additional operators that are shown to be necessary from the results of the study.

In large city districts an operator's training school is maintained where all operators are examined, engaged and trained. Great care is taken in the selection of operators, special attention being paid as to whether a girl has good eyesight, hearing, physique, a pleasing voice and an attentive and courteous manner. A separate switchboard is

provided in this training school having no connection with the regular telephone system, where the operator is taught to handle all kinds of calls that she would be likely to receive in actual service, there being a set of instructors who make up these calls. After some weeks in this training school, the operator is sent out to a central office and is permitted to observe experienced operators before being allowed to complete any calls herself. She handles only a few calls at first but gradually acquires confidence and speed until in time she becomes as proficient as the others. It is necessary that much care be taken and much emphasis be placed on this branch, because it is the operator who

comes into direct contact with the public and it is she who gives the public the impression that it has regarding the attitude of the Company towards its subscribers. It is the duty of the operator to let the public know that the Company is striving at all times to give satisfactory service and that it is endeavoring constantly to raise its standard.

This, in brief, is an outline of the principal functions of the traffic department of a telephone company as organized to-day. No attempt has been made to more than generalize the various elements considered because it would be impossible, in a short paper, to discuss all phases of even one division of the subject.

Central Offices and Some Types of Switchboards

By J. H. MAHAN

(Abstract)

BRIEFLY, there are five types of switchboards in this territory. They can be classed as "Magneto" and "Common Battery" Boards. Again the "Common Battery" Boards can be divided into—"D & A," "No. 9," "10" and "1" types. Although these are trade names, their understanding is general.

The offices are operated on several different bases,

ating and maintaining both come under the Bell Company's direct supervision. The "agency" plan is used in some of the smaller places while all larger places are "Company operated."

The speaker made a complete analysis of the situation by giving a description of each in order to emphasize the following points:

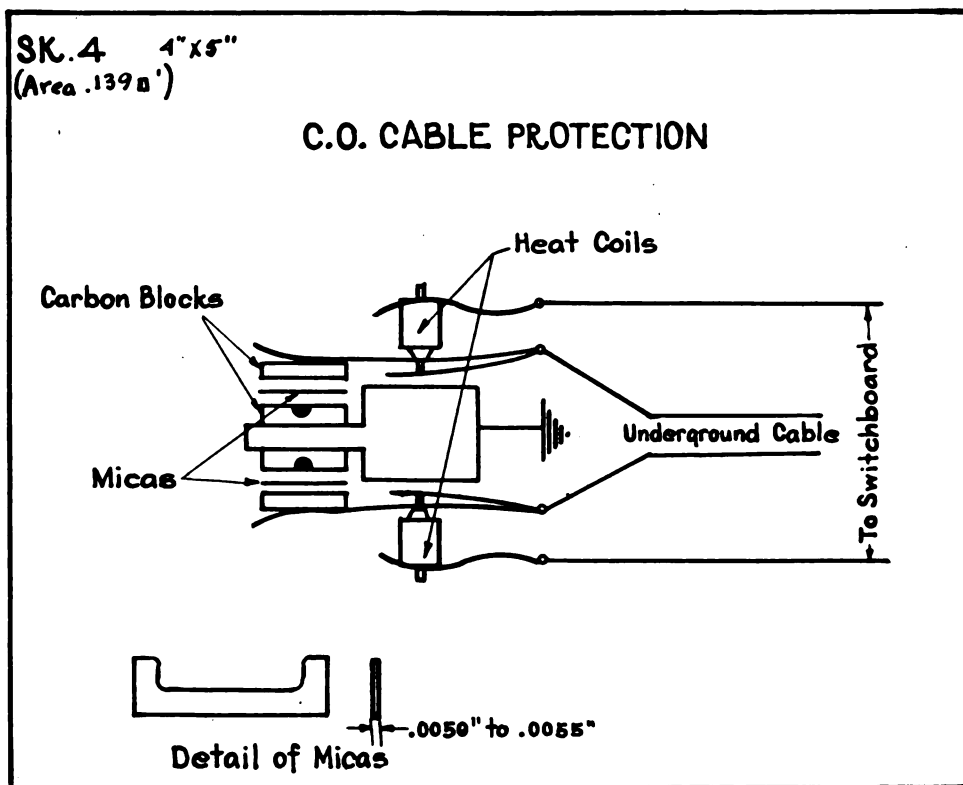


FIGURE 1

and the ones in which we are principally interested are "Company operated" and "Agency." In the "agency" office, the Bell Company pays some one else to operate the Board and hires extra help as needed, while it maintains the Board. In the "Company operated" office, the oper-

First, the type of building in which the office is located. Second, the location of the switchboard itself, whether it is in a room or store or some other special operating room.

Third, the difference in the various types of boards.

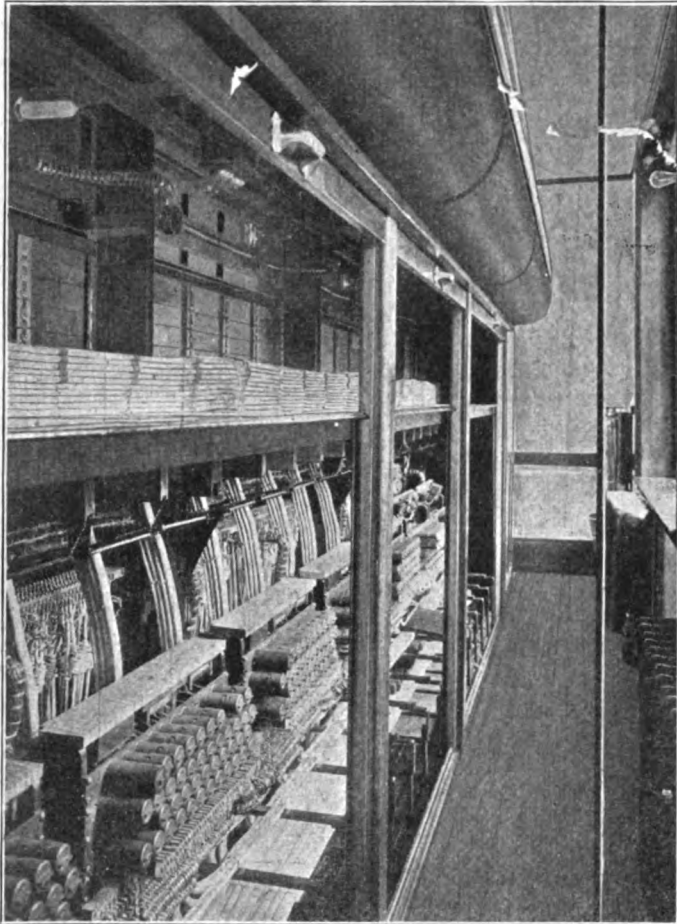
ENGINEERS' CLUB OF PHILADELPHIA

Fourth, the question of protection.

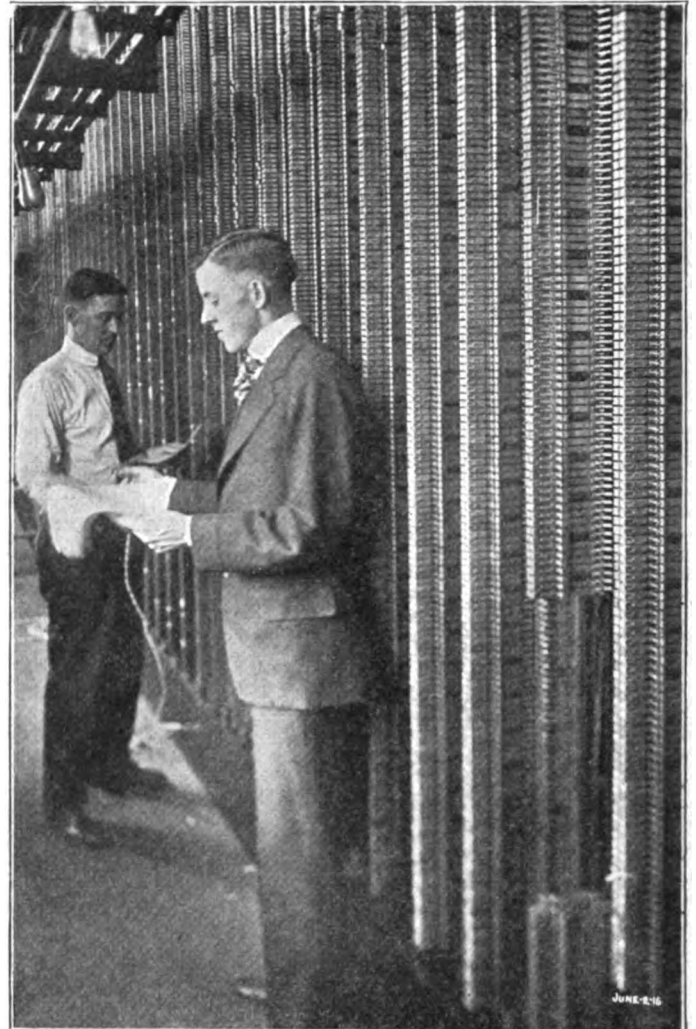
In order to protect the offices and lines from lightning and other high voltage discharges, protective devices are installed at various points. In the central office, efficient ground devices are installed where possible. A photograph was shown of a coke ground. A lead goes down in the ground about 6 feet to a large copper can filled with

coming in through the underground cable heat up the "heat coils" due to their resistance and due to the heat generated, unsolder a collar from the central pin allowing the outside spring to push the pin against the ground bar, thus grounding out the line and protecting the telephone equipment.

Should a high voltage discharge come in over the wires,



REAR VIEW—LARGE COMMON BATTERY SWITCHBOARD



PROTECTOR SIDE—MAIN DISTRIBUTING FRAME

crushed coke and a "tie" wire connects this first ground with a second ground.

Figure 1 (sketch 4) illustrates the methods used to protect lines against small sneak currents and high voltage discharges. Small sneak currents above a certain value

it would immediately jump to ground through the .005-inch air gap provided by the micas and carbon blocks. Successive discharges would cause the half round globule of alloy to melt and make a solid ground contact between the two carbons and the ground.



Illuminating Engineering Society

Philadelphia Section

ROBERT B. ELY, Chairman

T. ELMER MOON, Secretary



THE regular monthly meeting of the Philadelphia Section of the Illuminating Engineering Society was held on Friday evening, December 15th, at the Engineers' Club.

Mr. Walter Sheldon Rodman, Professor of Electrical Engineering at the University of Virginia, presented a most instructive paper on "The Lighting Schemes of Thomas Jefferson." Prof. Rowland, of Drexel Institute, gave the second of the series of thirty-minute informal talks on "Lighting Fundamentals."

Prof. Rodman's paper was of intense interest and profusely illustrated by lantern slides of interior and exterior views, floor plans and elevations. The main theme dealt with the methods by which Thomas Jefferson had embodied the finest examples of architectural beauty and simplicity with the fundamental principles of daylight illumination, in the design of his home, Monticello, and his creation (along with Mr. Madison and Mr. Monroe) the University of Virginia.

Considerable attention was paid to detailed measurements of the daylight illumination obtained throughout the day in various rooms at Monticello, in the Rotunda at the University of Virginia and a typical room for students at the University.

The paper was distinctly a triumph from the point of architectural design and in several instances disclosed an unusual use of skylights carefully planned and skilfully located to obtain sufficient daylight illumination in the interior of his residence. Excerpts from Mr. Jefferson's original notes showed the painstaking detail development of every window, door, and lunette to insure a cheerful home at all times. Another interesting point brought out was

that in the construction of the various buildings of the University deviation from Mr. Jefferson's original plans as a rule gave inferior results and caused a return to his design.

Many examples were also shown of the character of the artificial illuminants used in Mr. Jefferson's time.

Prof. Rowland, in his continuation of the series on "Fundamentals of Lighting," devoted a considerable portion of his time to an explanation of the law of inverse squares and the relation of the flux of light to the illumination produced at any distance from the source. Several sample experiments produced a result that many paragraphs of words would only vaguely intimate.

Members of the local section will be sorry to hear of the recent illness of Prof. George A. Hoadley, one of the Managers, and Mr. Arnold F. Mayers, Chairman of the Publicity Committee.

THE reprints of the Illuminating Engineering Lecture Course recently held at the University of Pennsylvania it is hoped will be available shortly after the first of the year.

Members of the Illuminating Engineering Society may obtain copies of these reprints at a reduced price—not to exceed five dollars, prior to the date of publication. This price will be cost plus delivery and handling expenses, without any profit to the Society. It is expected that the selling price of the bound volume will be somewhere in the neighborhood of five dollars.

All orders for these reprints should be sent to Mr. Clarence L. Law, Irving Place and Fifteenth Street, New York City.

NOTICE TO MEMBERS

THE PUBLICATION COMMITTEE WILL WELCOME ARTICLES OF PERSONAL OR GENERAL INTEREST TO THE MEMBERS OF THE ENGINEERS' CLUB. ADDRESS ALL COMMUNICATIONS TO THE PUBLICATION COMMITTEE : : : : : :



Society of Automobile Engineers

★ ★ Pennsylvania Section ★ ★

JOHN W. WATSON, Chairman

A. K. BRUMBAUGH, Secretary
Autocar Co., Ardmore, Pa.



OWING to the fact that our regular meeting day falls in the Christmas Holiday week, the Governing Committee has decided not to hold a December meeting, but to make the January meeting a particularly notable one.

We are very anxious to make a good showing at the Winter Meeting which is to be held in New York, January 10 and 11, during the show, and we would particularly like to have a big representation from the Pennsylvania Section at the Professional Sessions on January 11. The new method of presenting papers which has been adopted, will undoubtedly make this day very interesting, and will enable you to get the fullest measure of benefit from the papers and the discussions.

We are advised by the Chairman of the Professional Sessions that the New York hotels are well filled up and that it will be necessary to wire at once to secure accommodations.

Thursday, January 11, will mark the busiest day in the existence of the Society of Automobile Engineers. Although the two preceding days will be devoted to special work of, the Standards Committee, the Professional Session has been condensed, and the important papers prepared by leading members of the profession have been scheduled to be presented at definite times during the afternoon of January 11, in the large Assembly Hall of the Engineering Societies Building at 29 West Thirty-ninth Street, New York City.

Efficiency will mark every step of this meeting, and

it is expected that more will be accomplished in this one day than has hitherto been the case when the Professional Sessions have extended over two or three days. Luncheon will be served during the meeting in the lobby adjoining the Assembly Room. After each paper, ample opportunity will be given for a thorough discussion. In order to accomplish this, papers will be distributed to members and only the abstract presented at the Session.

The Professional Session, which closes promptly at 4.30, will be followed by the annual dinner in the large Banquet Hall of the Hotel Biltmore. A reception and "get-together" meeting will be held at 6.30 during the hour preceding the dinner, and from the number of reservations already requested, it is anticipated that the Hall will be taxed to capacity.

The playtime of the Session comes at midnight, when the members and their guests will attend, en masse, Ziegfeld's Midnight Frolic on top of the New Amsterdam Theatre. The entire seating capacity for this unique performance has been purchased by the S. A. E. members, and the Frolic Committee has been kept busy returning the checks of several score of those who applied too late for reservations.

Manager Miles of the National Automobile Show has arranged for two admission tickets to the New York Automobile Show, which will be in progress that week, to be given to each member of the Society of Automobile Engineers upon personal application at the office of the Society in New York.

RETARDATION

By JOHN YOUNGER*

DURING the past two or three years, emphasis has been laid on the accelerative ability of cars. Designers have vied with each other in getting the last fractional inch per second, per second, into their performance curves. Advertising Managers have not been slow in accelerating the peaks a little further and finding that the public liked it.

"Get away," "Pick up," "Dash," "Verve," I have, myself, called it "Elan," are all familiar terms for the

engineer's word "Acceleration." There is as yet no term of endearment for retardation. Its significance has not gripped the people's imagination, and yet of the two, it is of more vital importance. The automobile death-rate increases in inverse proportion to the efficiency of the retardation curve.

In fast-rail traffic with many stops, the possible retardation curve is first studied. Running a continuous stream of cars through New York Subways, with an infinitesimal headway at rush hours, have caused their engineers to know almost to a fraction of a foot just

* Chief Engineer of the Truck Department, Pierce Arrow Company, Buffalo, N.Y.

where the brakes must be applied after Forty-second Street to bring the train to rest at Times Square.

Similarly in street car work. The profit that can be derived from a set of rails in a busy district is as much a question of retardation as of acceleration. The automobile moving rapidly in and out of city traffic, places, perforce, great dependence on its brakes, and actually, good braking contributes greatly to the feeling of liveliness. A car with good acceleration, but sluggish retardation, does not feel as lively as one with both good.

Retardation can be studied under two heads: retardation relative to the road, and retardation relative to the forces acting on the car. The primary object of the former is to slow down and actually stop the car. The object of the latter is to maintain the vehicle at a steady, safe speed, notwithstanding the forces (such as effect of gravity on a hill) that are tending towards acceleration. Both actions have special characteristics which will be taken up separately.

TIRE ADHESION

Obviously, the first consideration is the boundary between the car and the road—the co-efficient of adhesion or friction of the tire. This varies greatly; the shape of the tire, the nature of its tread, whether it be solid or pneumatic, the compound of rubber used, play their share in varying this; whilst the very fact that the road surface ranges from cement or citrified brick to greasy mud, makes one realize how impossible it is to give figures which mean anything. Curiously, pneumatic tires have a co-efficient differing from that of solid tires, the writer having found it sometimes higher, sometimes less.

Mr. George Watson, before the English I. A. E., January, 1916, gives .4 as the maximum adhesion of solid rubber tires on good macadam. Other authorities state that .6 is the figure for pneumatic tires. The writer has found an adhesion of .6 for solid rubber tires on cement and vitrified brick roads, and only .5 under similar conditions for pneumatics. The measurement of tire adhesion is, however, inextricably mixed up with that of road resistance, the number of factors entering in being exceedingly large.

A convenient and accurate standard to assume is .5, and this is concurred in by several authorities.

I have been careful to use the term adhesion in the foregoing, as specially applicable to the case where the tire does not slip relatively to the road. When the tire slips, the proper term is friction.

There being no relative motion between the surface of the tire and the road (the road moving back at the same speed as the tangential velocity of the car), it is obvious that the case is analogous to the body at rest on an inclined plane. The co-efficient of "stiction" or adhesion is greater than that of friction. Incidentally, this partly explains why a car stops more rapidly when the wheels are kept moving, than when they are locked.

ROAD RESISTANCE

Nature has been very good on the whole. Smooth asphalt concrete, brick, good macadam, which offer little resistance to the passage of the car, have fortunately a good co-efficient of adhesion—when dry, thus offering fair compensation. As is well known, road resistance ranges from 5 pounds to over 300 pounds per ton. It is a factor which must be considered in the study of retardation.

WIND RESISTANCE

This may very conveniently be taken as .002 $A v^2$ in pounds, where A is projected frontal area in square feet, usually about 25 square feet. Again, this is a variable depending on wind velocity and direction. Strictly speaking it should always be considered, but its effect is small and may be left out in comparison with the other items.

POSSIBLE RETARDATION

Given brakes on all wheels, and neglecting road resistances, we would have a retarding force of .5 W ;

whence from the inertia formula $F = \frac{W a}{g}$

we have the retardation = .5 g
or 16.1 ft/sec/sec.

The average car has, however, the brakes on the rear wheels only. Its weight is distributed equally on front and rear wheels as a rule.

The retarding force is then $\frac{.5W}{2}$ and thence

the retardation is .25 g
or about 8 ft/sec/sec.

With this latter, we have that

A car going 60 m.p.h. will stop in 11 seconds and cover 484 feet.
A car going 30 m.p.h. will stop in $5\frac{1}{2}$ seconds and cover 121 feet.
A car going 15 m.p.h. will stop in $2\frac{3}{4}$ seconds and cover $30\frac{1}{4}$ feet.
A car going 5 m.p.h. will stop in .625 seconds and cover $4\frac{1}{2}$ feet.

The presence of road resistance, wind resistances and chassis losses, will bring this figure of 8 ft/sec/sec. up very closely to 10 ft/sec/sec. deceleration, so that a car travelling at 30 m.p.h. will stop in 4.4 secs. and cover about 97 feet.

COMFORT

Everyone has experienced the peculiar feeling of being shot forward in the seat when brakes are suddenly and strongly applied in railway train or street car. The eyes have not prepared the body to brace up against the action, whereas in an automobile the eyes are usually on the alert, and the body is well prepared for violent retardation.

Yet, in railroad service the best stop is that recorded in March, 1914, when a Pennsylvania train experimenting with a new type Westinghouse brake, stopped in 1000 feet from a speed of 60 miles per hour. This took $22\frac{3}{4}$ seconds and was a retardation of only 3.87 ft/sec/sec.

Experience has shown that an acceleration or deceleration of 6 ft/sec/sec. is about all that can be borne in comfort by passengers. There are naturally many who cannot even bear this, and many who can bear much more. It is interesting to note *en passant*, the terrific velocities that man can stand, but the very small changes in it.

Extreme change, such as stoppage against a stone wall, will catapult passengers out of their seats with great violence. Six ft/sec/sec. is on the verge of discomfort; it is, I think, reasonable to believe that 10 ft/sec/sec. is the maximum that should be cared for. This, by the way, is equivalent to an applied horizontal pressure on the passenger of about $\frac{1}{3}$ his weight. So with the chassis. The inertia effects on the body fastenings, engine and transmission fastenings, are usually based on the acceleration at low speed, and this is very rarely more than 10 ft/sec/sec., the equivalent of a 30 per cent grade.

FOUR-WHEEL BRAKES

It is thus seen that for the average vehicle, there is little to gain in putting brakes on more than the two rear wheels. It is true that they could be so adjusted that the braking friction were only half what it might be, but this is exceedingly difficult to determine and keep in adjustment, and there is real danger in excessive retardation being produced under the normal circumstances of driving over dry roads. Railroad conditions are not analogous, as a co-efficient of adhesion of .2 is about all that can be reckoned on against our .5 to .6 on rubber-shod automobiles.

Two-wheel brakes, provided they function properly and are used intelligently, will give all the retardation that it is safe to use.

This is not, of course, the only reason why all wheel brakes have not been adopted generally, but it is one of them.

TRUCKS

The foregoing remarks have dealt mostly with a car whose weight is distributed equally fore and aft. The passenger load is usually a small percentage of the gross weight, and there is an obvious limit to the human capacity of the space.

The truck is often twice as heavy when loaded, and overloading to the extent of double the rated amount may occasionally be met with, though this evil is, I think, getting less.

There are still a few trucks whose load is more or less balanced between front and rear wheels, but they are in the minority. The load is most usually carried 75 per cent and upwards on the rear axle, and it is this the designer must pay attention to.

The weight of a truck is in no proportion to its load. A 2-ton truck with body may weigh 6000 pounds, or 1.5 times its load, whilst a 5-ton truck with body may weigh 10,000 pounds, or equal to its load.

Each truck, therefore, must be considered individually, and the final braking effort on the circumference of the

rear wheels be made equal to at least .5 times the loaded weight at the rear wheels. Assuming the speed of the truck at 15 m.p.h., this will stop the truck in about 30 feet, without causing the load to pile up behind the driver's seat. This should be short enough for any board of councilmen, and should preclude the necessity for providing safety guards or fenders.

THE PERSONAL EQUATION

The human element in producing retardation is very great. Brakes must be skilfully applied, so that under varying road conditions the pressure is just enough to not lock the wheels, otherwise a dangerous skid might result. Women are driving cars in increasing numbers. They are unable to exert the same pressure on pedal or lever that a man can. Designers must awaken to this problem. If a light pressure is given, brakes must be adjusted more often, unless some mechanical or electrical means be supplied for assisting the human strength. As stated, this must be very delicately arranged to give perfect gradation of pressure, but the problem should not be impossible of solution.

CONTINUOUS BRAKING

The question of absorption of energy has been ignored in the foregoing, inasmuch as the time interval is short, and the material surrounding the brakes well capable of taking up the heat developed. On a long hill, where brakes are applied continuously, the problems that arise are different. Here there is no question of inertia effects, or of skidding, or of stopping space available; the great question is one of absorption of energy and hence radiation of heat.

At the top of a hill, a car possesses both kinetic and potential energy. If at the bottom the car's speed is unchanged, then the brakes, plus the road resistance, have absorbed the potential energy. The weight of the car plays an enormous part in this, the absorption of energy being in direct proportion to it. Whilst the truck lacks the speed of the touring car, it makes up for it by weight in hill descents, and the retardation problem is the more difficult.

A SPECIFIC HILL

There are many hills 10 per cent grade and one-half mile long. A 5-ton truck, gross weight 20,000 pounds, has a gravitational component down hill approximately 2000 pounds. Assuming a road resistance of 50 pounds per 2000 pounds, or 500 pounds gross, we have a net force tending to accelerate the truck down hill, of 1500 pounds.

If a safe speed of 10 miles per hour is maintained the time of descent is 3 minutes. The energy absorbed by the brakes is

1500 $\times$ 2640 ft. lbs.

or at rate of 1,320,000 ft. lbs. per min.

or 40 H.P.

or 1700 B. T. U.'s per minute.

Take now the fact that approximately 50 pounds of metal with a specific heat of .12 absorb this, we have enough heat generated in 3 minutes (neglecting radiation) to raise the temperature of the mass from 60° F. to 900° F.

In a practical corroboration, it was found there was 1 square foot of radiating surface from which the balancing temperature was calculated to be about 760° Fahr.; the surface at the foot of the hill was certainly nearly that, being a black heat.

There are hills much worse than this in length and grade, the only salvation being the use of the engine, alternating with hand and foot brake. For the great majority of touring car work the normal brake is satisfactory, but for hilly and mountainous districts there is still much to be done. European designers have been well aware of this, some of the Italian designers whose testing grounds were the Swiss Alps, have even gone the length of water cooling their brakes, both by drip and by water jacket.

AUXILIARY BRAKES

Only one truck, and that one of Swiss design, has attempted to solve this problem, and that by means of a device which shifts the camshaft longitudinally, converting the engine into what is really a two-cycle air compressor, the carburetor being shut off and fresh air admitted through a manifold port.

From time to time brakes working on a hydraulic principle have been devised, but always there has been the problem of cooling the liquid and ensuring the tightness of pipes and joints.

It is the writer's impression that as the country roads get opened up more, and trucks are used in outlying districts, a demand will arise for a third brake for hilly districts. This will enable the vehicle to coast down a long incline at a predetermined safe speed, with no wear and tear on the engine or undue heating of the brakes.

SUMMARY

Co-efficient of adhesion of average rubber tire, with good macadam, asphalt, concrete or brick road—.5.

Maximum retardation car should be capable of 10 ft/sec/sec.

Usual retardation for slow down or stop—6 ft/sec/sec.

Pedal push a man can exert in properly designed seat—300 pounds.

Pull a man can exert on brake lever—upwards of 100 pounds.

Efficiency of average brake linkage allowing for usual weak system of lubrication—about 75 per cent.

Radiation that should be provided for long hills—about 200 B. T. U.'s per minute per ton weight of car.



American Society of Mechanical Engineers • Philadelphia Section

EMMETT B. CARTER, Chairman

W. R. JONES, SECRETARY
Eng. Dept. Univ. of Penn.



THE Cooling of Water for Power Plant Purposes" was the subject of a very interesting and instructive paper delivered at a joint meeting of the Franklin Institute and the A. S. M. E. in the Franklin Institute Auditorium on the evening of December 14.

Professor C. C. Thomas of the Department of Mechanical Engineering of the Johns Hopkins University, and well known as a Consulting Engineer, gave the address. He gave a brief resumé of the methods used in cooling water, including a number of primitive forms of apparatus, then towers, various forms of screens and then cooling ponds. Following this, he showed a special form of nozzle which he has developed, and described an extensive series of experiments which have resulted in curves of efficiency. A complete analysis was made with these curves and figures relating to the power consumption per

gallon per hour per degree cooled, and then compared this quantity with different types of nozzles.

Professor Thomas stated that it would be rather in the nature of a report of "progress" and not a completed investigation.

A very large portion of the audience was composed of members of the local section of the A. S. M. E.

FEBRUARY MEETING

On February 1, Mr. C. J. Ramsberg, Vice-president of the Koppers Company of Pittsburgh, will give a paper on the subject of "Coke Ovens and Their By-Products."

The meeting will be a joint one with the Franklin Institute, and will be held in the Franklin Institute Auditorium. The subject of the paper holds such a position in the industrial world that there will, no doubt, be a large attendance.



Philadelphia Association of Members of the American Society of Civil Engineers

SAMUEL T. WAGNER, President

C. W. THORN, Secretary



Obstacles to Success in Engineering and Advice to Young Engineers

By SIR MAURICE FITZMAURICE

(The following is abstracted from the installation address of
Sir Maurice Fitzmaurice, as resident of the Institution of Civil
Engineers, November 7, 1916.)

I DO not suppose there are any engineers in this room who have carried out undertakings of any extent who have not had, at some time or other, to lament failure or accident in connection with at least some part of their works. For many years I was fortunate enough to be engaged by some of those great engineers whose portraits we see surrounding us, and I cannot recollect any large undertaking which has not at times caused my chief considerable anxiety owing to accident on some portion of the works, or from alteration in design having to be made on account of unforeseen causes. Since I have been carrying out works on my own responsibility, I have found a similar state of affairs, and I believe all engineers have from time to time experiences of a like kind.

I am not now speaking of great calamities or disasters. . . . I am referring to those misfortunes which happen more or less on all works of engineering construction. Although very often not of great magnitude, they cause the engineer, the contractor and client great anxiety and disappointment. The engineer in the case of accident causing loss of life, even although it may be in connection with temporary works for which he is not directly responsible, feels it very keenly, and probably thinks he might have taken, or caused to be taken, some precautions which would have prevented it. Although even a serious accident on works may not entail any extra cost to the engineer's client, it may necessitate such an addition to the time of construction as will seriously dislocate arrangements made for the use of the works, and may in that way be a cause of serious financial loss.

The question arises: Are engineers, as a rule, too optimistic in designing their work and in their estimates of time and cost? This question, however, only deals partially with the class of failures I am considering, and before going further I want to clear the ground in connection with one important point.

Works of any size are generally carried out by contract, and the contractor employed has a very important bearing on the question. Probably every engineer would like to choose as contractor for any work which he has to

undertake, that firm which has previously carried out similar work for himself, or for engineers he knows. This course is, however, one which cannot be adopted, except in a few special cases, owing to obvious reasons.

As is well known, there are two ways of obtaining contractors for works, either by open tender or by asking selected firms to tender. In the first case it is generally understood that it is quite allowable not to accept the lowest tender if the firm has not the necessary experience and standing. There are, however, very often considerable difficulties in rejecting low tenders of unsuitable firms, and explanations to clients are often difficult.

I do not know any more unpleasant position, both for contractor and engineer, than when it is evident that a contract is being carried out at a loss. In such cases the contractor, on the one hand, may be forced to carry out the work in a slow and unsatisfactory way, and the engineer, on the other hand, feels that he cannot well press the contractor to spend more money on plant and staff.

I now come back to the question whether engineers, as a rule, are too optimistic in designing their work, and in their estimates of cost and time. On full consideration of the matter I am inclined to think that we must sometimes plead guilty to this charge, although the optimistic view and under estimates of cost and time are not always willingly arrived at.

What, shortly, are the principal matters which cause us trouble? The first one, in my opinion, is the small knowledge we are able to obtain of the conditions which exist below the surface of the earth, on which everything has to be founded; secondly, the risk which it is necessary to undertake as regards conditions of weather while works are being carried out; and thirdly, the varying quality of many of the materials we have to deal with. There is a fourth matter, which affects contractors more than engineers—namely, the difficulty of estimating the cost of materials and rates of wages for a long time ahead. This last also substantially affects engineers' estimates when there is a long interval between the time when the estimates are made and that when tenders are received.

The difficulties I have mentioned, and many others, are, however, the reason why our profession is such an extremely interesting one. New unforeseen difficulties turn up every day, and new methods are being continually found out for dealing with them. Engineers and contractors have to design works and construct them to the best of their ability.

It is difficult to make suggestions to facilitate our work, but it has occurred to me on more than one occasion that our brother engineers on the other side of the Atlantic devote more time than we do to preliminary work and studies, particularly in the case of large undertakings. They appear in some cases to have taught their clients that time and money spent on very full investigation and preliminary studies give a very good return on the expenditure. The Governments of Canada and the United States are also not averse to collecting information about rainfall, river discharges and other matters, which information is at the disposal of those who wish to avail themselves of it. If we could prevail on our clients and on our Government to take similar views, they would also find that the money was not wasted. We are, however, as things stand, dependent to a great extent on experience and private investigation and experiment for the success of many of our works. We ought not, at the same time, to forget the great obligations which we engineers are frequently under to chemists, geologists, metallurgists, meteorologists, and others, for the great help which they ungrudgingly give us.

I hope, however, that the Government "Scheme for the Organization and Development of Scientific and Industrial Research" which has recently come into existence, and which has already made a grant to this institution for research work, may be a real help to engineers. The scheme in its main features is one conceived on broad and partiotic lines, which may lead to results even greater than were anticipated by those who framed it. As far as I know, the detailed arrangements under which it will be administered have not as yet been definitely laid down. Some, but not all, of the industries which may expect help are at the present time so engaged with war work that it is not possible for those controlling them to fully consider, much less to carry out, useful research work. Such work, to be of real value, must be undertaken in consultation with the different industries. It is, however, important that some definite lines for the working of the Government scheme should be laid down at an early date. I hope and believe that it may be developed on such broad, liberal and generous lines as will command general confidence. If worked on such lines the scheme will be of great value. "A great Empire and little minds go ill together. . . ."

I consider that there has been in recent years some improvement in general education, which tends to give capable boys the chance of taking up the profession of engineering when they have an inclination in that direction. Very much more, however, might be done in this connection. . . . While I need hardly say that I am

extremely keen about a radical alteration in our teaching, so that scientific education may be kept all the time in the foreground, I do not wish to see young men growing up without what in an old-fashioned way would be called a good general education. We at this institution have been altering our examinations and practical requirements from time to time so as to raise the scientific standard required for students and associate members, but we have not forgotten the value of a good general education. . . .

The examinations by the institution, or the corresponding ones at the universities, which have now for some time been required before a young engineer can become an associate member of the institution, are, of course, only the ground-work for the work to come later on. Nothing can take the place of experience and actual contact with difficulties. It is therefore necessary that an engineer should devote his time to getting all experience possible.

I have on one or two occasions been asked by a young engineer whether, of two posts offered to him, he should take that of one among many assistants on a large work with a small salary, or that of resident engineer on a small unimportant work at a considerably higher salary. Without hesitation I recommended the former position. I knew that on the large works he would see a little of almost every class of work, that even the temporary works of the one were probably more important than the permanent work of the other, and that the fact of being on a large work would be of great assistance later on, and would stand by him all his life. He would also have the advantage of daily intercourse with other engineers, and the emulation and friendly rivalry between them would lead to efforts on his part to hold his own. There also exists on large works a feeling, which I can only describe as engineering atmosphere, which may have a real influence on the life of a young engineer.

Experience and the passing of hard engineering examinations are, however, not the only requisites for success in our profession. I suppose there is no class of engineer more in request than the resident engineer with experience, who can "get on" with people. Engineers are afraid of assistants who can't get on with people. Such men irritate clients; they cause trouble whether they are on the engineer's or contractor's side. The capacity of getting on with people and still holding one's own has a distinct money value, and a very high one.

Closely akin to it is the one of being fair in dealing with questions which arise on works. The resident engineer and the contractor's engineer who are open with each other, and will not take any unfair advantage of one another, have both obtained a reputation of great value, and which may have a far-reaching effect even on both their firms.

All young engineers should take every opportunity of carrying out experimental work. Such opportunities occur on nearly every undertaking. It need not be orig-

(Continued on page 44)

American Institute of Electrical Engineers ♦ Philadelphia Section

H. P. LIVERSIDGE, Chairman

W. F. JAMES, Secretary
1442 Widener Bldg.

THE DECEMBER MEETING

DESPITE very discouraging weather conditions eighty-five members were in attendance to greet the speaker of the evening, Mr. E. J. Cattell, City Statistician. In an original and very entertaining manner Mr. Cattell presented the subject, "What Electricity Has Done for Philadelphia," and brought out many important and seldom appreciated benefits which have resulted from the development of the practical applications of electricity. With his characteristic energy and irrepressible optimism, Mr. Cattell pointed the way to great possibilities of the future.

A rising vote of thanks expressed the appreciation of the Section and it was very evident the talk was enjoyed by all present.

By courtesy of the General Electric Company, a three-reel educational picture, "The King of the Rails," followed Mr. Cattell's address, and in an interesting and instructive manner showed first the development of means of transportation from the primitive to the present and then in detail the actual construction of the locomotives now operating the electrified portion of the C. M. & S. P. R. R.

The usual social hour followed the adjournment of the meeting.

THE JANUARY MEETING

Special arrangements are being made and a large attendance is expected at the regular monthly meeting

which will be held at the Engineers' Club at 8 P.M. Monday, January 8, 1917. Mr. C. J. Russell, of the Philadelphia Electric Company, and well known to the Section, will address the meeting. The subject will be "Commercial Engineering." Be sure to be on hand. Come to the informal dinner at 6 P.M. Arrangements have been made to make this a "Long Table Get Together" affair away from the regular dining-room of the Club which you may have found crowded in the past. There will now be ample room for all and more opportunity to get acquainted.

FINANCES

Mr. M. G. Kennedy, Chairman of the Finance Committee of the Section, wishes to express the appreciation of the Committee for the prompt and very general response to its appeal for voluntary contributions to assist in defraying the local expenses. Have you sent him your dollar? If not, follow the crowd and make the Committee even more appreciative.

STUDENTS' NIGHT

Don't forget February 12, 1917, is Students' Night, and Mr. Charles Penrose, Chairman of the Special Committee in charge, will welcome your suggestions as to getting the students out and make it worth their while. Address him at 1000 Chestnut Street.

AMERICAN SOCIETY OF CIVIL ENGINEERS

(Continued from page 43)

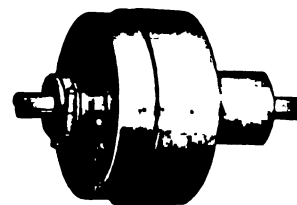
inal work, as that is not always possible, but even the repetition of work previously done gets one interested and accustomed to that class of work, and it may be the means of correcting and enlarging the work done by others.

There now comes probably the most difficult question of all for a young engineer, the change which makes him known, the opportunity by which he can show that his qualities have been under-valued. There are many curious ways in which this opportunity arises. He may work steadily for many years, and it may suddenly come in the most unexpected way, and it generally does come once if desired. . . . I am not, however, going further into this question to-night, except to point out that I am not at all sure that young engineers realize the importance of attending the meetings, joining in the discussions, and contributing papers to this and other institutions. I don't think I have ever written a paper, or got

out notes for a discussion, without discovering that there were several points on which my information was deficient in some particular, which otherwise I should not have known it was necessary to look further into. It is extremely difficult in many cases for even a very good young engineer to get himself known, and the reading of papers and joining in discussions is almost the only legitimate form of advertisement open to him.

My remarks are really reflections on the different events which have occurred during my own life as an engineer, extending now to over thirty years. I hope they at least show that there is still ample room for investigation and experimental work, which may enable us to give still greater value to our clients, and that it may influence young engineers especially to devote some of their time to that class of work whenever opportunity for doing so is present.

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Foreign Notes

Continued from page 17

GAS-ENGINE VIBRATIONS

THE electricity works of La Chaux de-Fonds, Switzerland, installed in 1899 in their power station two gas engines of the Gasometerfabrik Deutz, each developing 250 h.p. at 180 r.p.m. They are four-cycle engines with two parallel cylinders and cranks at 360 deg., each motor directly driving a dynamo. Each of the two units had to be erected on a block of concrete, 7 m. by 9.5 m. and 6 m. high, as the soil consists of loam and marl to a depth of 20 m. Soon after the installation the houses in the neighbourhood, especially those built on the same marl, were disturbed by vibrations, described as unpleasant though not dangerous. The Deutz firm fixed balance weights to the crank arms and to the flywheels. The result was that the wave length of the vibrations was altered, and that other houses were shaken. In order to reduce the trouble, the motor speed was lowered to 165 revolutions. That involved a sacrifice of power, of course, but as the motors were rarely wanted, nothing further was done until loss of water from the tank of a gas holder near by suggested that a crack had developed in that tank. The crack had probably been formed when a deep excavation was made near the tank; but it had apparently been widened by the vibrations, for the running of the motors certainly increased the rate of water loss. The motors were therefore stopped, and Dr. Stodola was consulted as expert. Dr. Stodola considered the balance weights to have been correctly estimated and placed so as to balance the horizontal reciprocating forces; but there were also centrifugal forces at right angles to the former and not acting at the centre of gravity, and these forces tended to make the machines oscillate in pendulum fashion together with their foundation on the elastic cushion of soil. To avoid the oscillation Stodola suggested that the balance weights should simply move in the horizontal plane, so that the centre of gravity of the system should remain in the same plane during the running of the engines. His suggestion could be carried out in two ways: either a balance weight might be added to each unit so as to quiet that unit, or the one unit might be balanced by the synchronous movements of the other unit. The adoption of the second method would have necessitated arrangements for ensuring a precise concordance of the two units and, further, an absolute rigidity of the foundations, which might have been secured by providing a heavy cast-iron frame round the two blocks of concrete. This solution was not tried, therefore. The first method looked simple and was adopted. From the end of the shaft of each motor a balance weight is so moved on horizontal guides by an auxiliary crank that this weight arrives at its dead point at the same moment as the piston. The resultant of forces of the two weights had to coincide with the resultant of the forces of the piston, i.e., it had

Continued on page 62



American Society of Heating and Ventilating Engineers • Eastern Pennsylvania Chapter

JOHN D. CASSELL, Chairman

GEORGE W. BARR, Secretary
Land Title Building



THE regular December meeting of the Society was held at the Engineers' Club on Thursday, December 14, at which time Mr. Stewart A. Jellett presented an admirable paper entitled "The Duty of the Engineer to His Client and Himself."

This paper was so well worth while and so thoroughly appreciated by the members present that it will undoubtedly prove of general interest to engineers and is therefore reproduced in full in these pages.

The Society was fortunate in having as its guests Messrs. E. C. Wiley, of Lynchburg, Virginia, and W. S. Moffett, of Staunton, Virginia. It is hoped that we may continue to have with us heating and ventilating engineers from the various cities in our section.

The new emblem of the Eastern Pennsylvania Chapter, which was recently designed by Mr. George Boone, Chairman of the Membership and Means Committee, was officially adopted by the local chapter and is now being used in the pages devoted to the interests of the American Society of Heating and Ventilating Engineers in the Proceedings of the Engineers' Club.

At the December meeting 10 new members were elected to the local chapter.

Mr. John Gormly was elected as Honorary member.

Messrs. R. C. Bolsinger, C. E. Bonnet, M. C. Gillett, Geo. A. Haupt, John J. Liner, Wm. J. Murphy, P. M. O'Connell, Chas. G. Reeves were elected members, while Mr. H. D. Kellogg was elected an Associate member. Total membership of the chapter now numbers 52.

The Duty of the Engineer to His Client and Himself

By STEWART A. JELLETT

WHEN our Secretary asked me to present a paper at this meeting he was kind enough to suggest as a subject that I discuss in some measure the relationship between the engineer and his clients. This will explain the title of this paper in which I shall endeavor to make clear what I believe the relationship between the client and his Consulting Engineer should be—not what it is in many cases. You will note that the duty of both the owner and his engineer to the contractors is also referred to, as part of the duty of each to the other.

The definition of the word "Engineer" which seems to cover most fully its application to the work of equipping buildings, is that given by Webster,—“a person skilled in the principles and practice of engineering. One who carries through an enterprise by skilful or artful contrivance; an efficient manager.”

Let me first, therefore, direct your attention to the fact that an engineer must not only be skilled in his work, but must also be an “efficient manager,” or in other words, a good business man. It is because of the fact that many of our engineers are not “efficient managers or business men” that many misunderstandings occur. The owner complains that the engineer is not taking care of his interests as he should and the contractors complain that they are not getting fair treatment. Our Engineering Colleges fall short of their duty to their students by not giving them at least the fundamentals of a sound business

training, sufficient at least to keep them out of trouble at the start of their career, and to which they can add as their work broadens. Please note therefore that what I have to say presupposes that good business sense goes hand in hand with good engineering practice and that both are essential to good engineering, whether viewed from the standpoint of the owner, the engineer or the contractor for the work.

When an owner and engineer first come together to discuss the employment of the latter by the former on any piece of work, it is essential to their future satisfactory relationship that certain matters shall be made clear.

First.—The owner must outline as fully as he can the scope of the work he contemplates having done, the conditions under which he wishes it done and the limit of cost beyond which he does not care to go.

Second.—The Engineer must make clear to the owner the conditions under which he will undertake the work, the amount of his fee and the work on which he expects his fee to be based. He should make clear what he means by supervision and inspection.

On first reading one might think that this will be comparatively easy, but in many cases it becomes as much involved as the engineering problem itself, for the reason that the owner in many cases is not familiar with engineering details while the engineer often (I regret to say) has little or no business training.

It is necessary therefore that if the work is to be carried to a successful conclusion, both owner and engineer deal honestly with one another, that the duty and relationship of each to the other shall be clearly understood before an agreement is entered into. The understanding when reached should be reduced to writing, and be signed as a formal contract. The relationship between the owner and his engineer is often unsatisfactory because in the first place, the understanding was not clearly defined and that no written contract was entered into. As many engineering undertakings carry over a period of one, two or more years, it is not only unwise but unbusinesslike to depend on verbal understandings. Men die—the relationship of parties to agreements and understandings changes—and others are called on to interpret them, who were not familiar with the original discussions and are not in sympathy with the engineer or his plans. In such cases the lack of a clearly written agreement usually means trouble for the engineer. Therefore I prescribe the use of a “sense” that is often overlooked when it is most important—Common Sense, as a panacea against future trouble.

Generally speaking, the engineer is employed by the owner to secure for him the equipment required at the least cost, and this is the correct understanding, provided both parties clearly understand the full meaning of the words “least cost.” The spending of the owner’s money honestly and efficiently is very much more difficult than spending one’s own money, because you are free to experiment with your own money and time, but not with your client’s, except with his consent and full knowledge of conditions. Even then it is dangerous, should the experiment not result satisfactorily, for often the owner’s recollection of the understanding is not clear. Failure on the part of the engineer to get desired results has been known to seriously affect the owner’s memory.

It is important for the future satisfactory relationship of owner and engineer, that the engineer shall approach the problem from the owner’s point of view, which is usually the financial one, and outline what can be done for the amount the owner is willing to expend. If the results desired can be obtained within the upset price, then the problem becomes quite easy of solution. The engineer’s real difficulty, however, is in satisfactorily meeting the requirements when the funds available are insufficient to complete the plant properly. The solution under such conditions, which at first seems to many engineers the only reasonable one, is to cut as close to the line on the capacity of the plant as possible and then to select apparatus and materials that he knows are not of the highest quality but the use of which will enable him to give the owner a plant that will meet his needs for the money he is willing to expend, but the conscientious engineer will exhaust the subject before he will approve of any such arrangement.

Granting that it is to the engineer’s interest in time saving and cost of planning, to go ahead on this basis is an admission that the owner’s interests have not had that careful consideration he is entitled to receive. Before making any such recommendation it is the duty of the

engineer to see if it is not possible to meet the immediate requirements (even though you cannot complete the plant fully, using high-grade apparatus), within the sum available and so arranging the plant that additions can be made later when further money is available. In other words, as every engineer knows, there are no bargains (as the word is generally understood) in buying machinery or equipment. Make this clear to the owner and show him that it is to his interest (assuming his business or investment to be a permanent one) to purchase only first-class apparatus, as by so doing he will get better service at lower operating costs and with less depreciation. It is far better that the owner purchase a plant of first-class machinery without any reserve capacity, that can later be increased by additions, than to install the full equipment including a reasonable reserve using inferior machinery. It is a serious mistake to make the price to be paid, the first consideration when purchasing power plant equipment or other similar machinery.

It is important therefore that the engineer advise with his client as to the results desired or necessary, keeping always in mind possible future additions to, or requirements from, the plant to be installed. It is just here that the engineer can be of most use to his client, because with his expert knowledge of the problem in hand he should advise and direct his clients in matters which he (the owner) often does not understand clearly.

If the owner wishes you to place the work in a manner that you believe or know will not bring satisfactory results, or that you know is radically wrong, make it clear to him from your point of view, and if he is unwilling to follow your advice, it is your duty to withdraw from the work. I have never known any engineer to produce satisfactory work when his heart was not in it, or when acting under directions he knows to be wrong.

When retained on any piece of engineering work it becomes the duty of the engineer to ascertain just what work the owner wishes him to plan, together with its relation to any other work already in place, under order or being designed by other parties, in order that his work may harmonize with other work relating to it in any way. Find out also the results the owner wishes to get, that is, quantity of output, efficiency, etc., and to what extent the work you are called on to design bears to the completed whole. After getting all this the next important question for the engineer to determine before going to the expense of making plans, is to find out if the results desired can be provided in an efficient manner within the cost limit.

If the work cannot be done in an efficient workmanlike manner for the amount allowed, make the fact clear to the owner, so that he will thoroughly understand it, and when he does, advise with him as to what is best to do, either increase the cost allowance of the work or cut down the capacity or efficiency of the plant, remembering always that you are spending the other man’s money and that you are in no way justified in misleading him, either as to the cost of the work or the results he may reasonably expect to attain.

The other extreme to which engineers sometimes go, is to plan an equipment which is obviously beyond the reasonable needs of the building in which it is to be installed. This does not refer to the capacity of the plant only but in some cases the quality of the material used; for example, sometime ago I examined the specifications for a building to be erected in New York City for a wealthy estate. The building, quite a large one, was very elaborate and contained in addition to a vacuum system of heating, a very complete ventilating system. Notwithstanding the fact that the heating specifications limited the maximum pressure to 2 pounds, all the pipe and fittings for the entire system were required by the specifications to be made "extra heavy" and all the steam lines and return lines were to be covered with double thick covering, then covered with canvas sewed on and painted three coats. The galvanized iron tempered air ducts and the cold air supply ducts for the ventilating system were covered with two thicknesses of 1-inch magnesia blocks with a hard finish, $\frac{1}{2}$ -inch thick; then covered with canvas sewed on and painted three coats. The whole plant was designed in the same extravagant manner. When the bids were received they were so excessive that the owner hesitated to go ahead and called for other advice, with the result that the cost of the work was reduced over \$100,000, the building remaining the same and the plant as installed being first class in every respect, meeting all the conditions as required by the original specifications. It is unnecessary for me to say that the original engineer for this plant failed in his duty to the owner.

The manner in which the engineer approaches a new problem very often determines whether the owner's interests are to be properly taken care of or whether they are to be ignored. By this I mean, whether the engineer considers the problem as a strictly engineering one or whether the engineering problem is to be intimately associated with the financial interests of the owner. There are many plants designed and installed that are interesting from an engineering point of view but do not earn any return on their extra cost. Such a plant from my point of view is poor engineering and no engineer is justified in spending the owner's money in this way. The engineer with business training and experience first puts himself in the owner's place and calculates the results that can be obtained for the money expended.

Some years ago I had as an assistant a very intelligent, well-educated engineer who had been an instructor in an engineering college. One day I handed him plans of a building together with outline directions as to the character of the power plant and accessories that I thought best adapted for this particular building. A day or two later he reported to me that he did not think that a plant designed as I directed would be the best that could be planned for that building; that he had in mind changes that would make the plant more economical in fuel. When I asked what the saving would be, he said he approximated that if the changes were made that he had in mind, the coal consumption would be some 200 tons per

annum less. I then inquired as to probable additional cost of the plant designed as he thought it should be and was advised that it would probably add about \$17,000 to the cost of the plant that I had outlined for him. As coal was at that time selling at \$3 per ton I wanted to know if he would invest \$17,000 of his own money for a return of \$600 per annum, not taking into account depreciation and repairs on the additional apparatus. He was of the opinion that that was not the way to approach the problem, and when I turned his scheme down, telling him we were not justified in spending the owner's money in the manner outlined by him, he was very much disturbed and stated that the plant designed as suggested by him would, from an engineering standpoint, be very much more interesting than my scheme. It is just such ideas as this, overlooking entirely the commercial side of the problem, that prevent many engineers from attaining the position in their profession that they should attain, based on their engineering knowledge and ability.

The lack of business training is a very serious handicap to success in the engineering business. I have often been accused of approaching a new engineering problem from the commercial side rather than from a strictly engineering one, and I plead guilty because I do not believe it is good engineering to waste the owner's money, and it is just as surely poor engineering to design a plant to cost more than the owner is justified in spending to do the work properly and economically as it is to underestimate what is needed.

The engineer should be particularly careful in submitting approximate estimates of the cost to the owner, not to mislead him. The engineer who either intentionally or otherwise, submits to the owner an approximate estimate of costs, considerably below what it is reasonably worth, makes a serious mistake. If he submits such an estimate, knowing it to be too low for the purpose of inducing the owner to go ahead with it, he is, in plain words, dishonest, because he knows that if the owner goes ahead, and part of the plant is erected, the owner is committed to seeing it completed, even though he may not be financially in position to carry it through.

After the general scheme of the plant to be designed has been agreed on with the owner and its various parts and their relation to one another has been definitely determined, comes the important question of the selection of the apparatus to be used, and it is just here where the engineer with business experience is of the greatest possible value to the owner. In some cases, due to the arrangement of the building, the structural steel frame, etc., certain machinery must be put out of consideration because of space limitations, so that it is well to determine as soon as the general plan of the building is settled, what type of apparatus is best adapted, keeping in mind conditions required in the building, that is, the load to be carried, the average hours that the plant is run at or approaching maximum, and the number of hours that small demand is made upon it. The general scheme of the plant must be worked out to meet the varying conditions in the building, keeping in mind always the oper-

ating costs and up-keep. My attention has been called several times to plants in which a very large number of electric generator units, pumps, etc., were installed, the idea being that the load varied from time to time during the day and as the load decreased or increased, more or less of the units were added. This in many cases is entirely justifiable, but it can be very much overdone, particularly when viewed from a business standpoint.

For example, I examined a plant some time ago in which there were five engines and generators, two of 150-kilowatt capacity, one of 75-kilowatt, one of 50 and one of 25. The peak of the load required the two 150-kilowatt machines for a comparatively few hours. Later, one of them was shut down and the 75 was thrown in, in addition to one 150, and then the second 150 was cut out for the early evening load, leaving one 75, and later the load was cut down to 50, and after midnight to the 25. On the face of it, this looked all right. Actually it was an expense to the owner. The load after midnight approximated the full capacity of the 25-kilowatt machine and after the 150-kilowatt machine was shut down the load approximated about 50 to 55 kilowatts, although the 75 was put on. The plant could have been handled with three machines instead of five, and while there would be a difference in economy between running the 75-kilowatt machine with 25-kilowatt load for a few hours each night, this difference in economy would not pay 1 per cent on the additional investment called for by the purchase and installation of the 25- and 50-kilowatt machines, to say nothing of depreciation, insurance and space occupied. The engineer for this work failed in his duty to the owner because he did not take into consideration the return the owner would receive on the additional investment.

The make of the apparatus is also of great importance. No engineer is justified in buying new and untried types of machinery for an owner except with the owner's full knowledge and consent. You may say, the engineer who sticks to the well-known types of apparatus is not likely to progress, my answer is that his duty to the owner comes first, and this duty to the owner not only requires him to buy machinery that is tried and proven satisfactory, but there is a further reason for it; that in the course of my business experience I have noticed that a very large percentage of the concerns making new apparatus, either go out of business altogether for want of sufficient capital or special merit in their machinery, or merge with other concerns. I do not know anything much more unsatisfactory to an owner, when a year or two after he has put into service a new plant and requires some parts for repairs, than to find that the concern has either gone out of business or has changed its patterns to overcome defects that have been discovered in service on the machines so recently put on the market.

Next to the selection of the machinery is the selection of contractors who are to do the work, and this selection under present conditions is a very difficult one because the present methods of competition have not been conducive to good workmanship. Modern competition has not only affected the contractors themselves but their workmen as

well, and there is a dearth of skilled mechanics due to the fact that in many directions there is no demand for them. The definition of the word "competition" is the act of seeking or endeavoring to gain what another is endeavoring to gain at the same time. Unfortunately we have grown to associate this word with one meaning only, that of price, and the word to-day as we use it means endeavoring to gain what another wants by the exercise in many cases of trickery without regard to perfection, excellence or quality. Such competition is unfair. The only phase of competition which can benefit an owner is "quality competition and this is the exact opposite of price competition." "To such extremes has the meaning of the word been distorted as to almost blot out its primary definition which meant competition in feats of skill or art, which always has and always will mean strength, perfection, excellence and quality."

The owner's idea of competition is not always to get a fair value of the work. Sometimes the engineer will find an owner who wishes to invite a notorious price slasher, who does poor work, to whom, under no consideration, would he give the work, with the idea that this bidder shall set the pace for the others and help him in some way to get the work done by a competent contractor at a price below what the work is really worth. It is the duty of the engineer under such conditions to insist that the owners shall not invite bidders to whom he is unwilling to give the work. It is unfair to the bidder because it costs money to make estimates.

The contractor's idea of competition is, in many cases, to determine how he can cut corners and meet specifications in order that he may feel safe in submitting a bid below the real value of the work, if done as the spirit of the specifications intend it shall be done. In cases where the specifications and plans are not clearly expressed, the unscrupulous bidder promptly takes advantage of these conditions. It is important, therefore, for the owner's interests, that contractors shall be selected, based on their experience, ability and business reputation.

Again, bidders vary on the different classes of work. Certain work requires individual personal skill and attention of the contractor while other work requires organized capacity and equipment because of the magnitude of the operation and the time in which it must be completed. It is manifestly unwise from the owner's point of view to select for the large important work, a contractor without the equipment or experience. It is equally manifest that on some small work that requires the most careful detailed supervision and inspection, that it be not entrusted to the larger concerns who in turn will delegate it to some one of their junior employees. Another point in connection with bidding competition that I wish to draw your attention to is that frequently a competing bidder will make a mistake in his estimate by some oversight in the making up of his final figures. When bids come to the engineer, which are manifestly below the cost of the work or are excessively high, I take it to be the duty of the engineer to bring the attention of the contractor to the fact that his bid seems to be at variance with the

conditions, and ask him to look over his figures carefully to see whether he has or has not made a mistake. This is of more importance where his bid is too low. I do not think it is honest on the part of the engineer receiving the bid, which he knows is below the absolute cost of the work, without any overhead business expense or profit, to have the owner accept this bid without directing the attention of the contractor to his estimate, and asking him to check it carefully. It is to the owner's interest that he should do so, although it is sometimes hard to get an owner to see that it is to his interest to spend more money than the bid submitted in error would call for, but the contractor who takes the work below what it is worth soon finds it out with the result that if he is not overly scrupulous he will cut all the corners possible to cheapen the work and no amount of inspection will catch every detail of concealed work, or else he will neglect the work in the interest of other work on which he is making a profit and this also is against the owner's interest. The contractor is just as much entitled to a square deal as the owner and it is the business of the engineer to see that he gets it.

A few weeks ago in conference with the head of a large corporation who had about completed some new buildings, this official complained to me about the excessive amounts they had been compelled to pay for a considerable amount of extra work that it was found necessary to do. He felt that the contractor who had taken the main work at a price considerably below others, and presumably below what it was worth, was taking advantage of him and that their architect had been careless in preparing the plans and specifications. He may have been right in both opinions. The contractor may have deliberately taken the original work below its fair value, noting that the plans and specifications were not very clear and definite, and with the full intention of taking advantage of the situation and getting back on the extra work sufficient margin to make up for his deficiency on his original contract. The work taken by a contractor below a fair price is rarely ever satisfactory. You generally get what you pay for, seldom more, sometimes less, but if you start out by being unfair to the other party to the agreement, you usually get less. Do not have business dealings with a dishonest or tricky contractor, and there are such. Some one is certain to be the loser and it usually is not the tricky contractor.

I think it is also the duty of the engineer to beware of the contractor who, in soliciting an opportunity to bid on the work, offers to give you a bond. Look behind the bond for capability and responsibility. There is nothing much easier to get to-day than a bond but if work turns out to be unsatisfactory the bond rarely ever makes it so. It is the duty of the engineer therefore to insist that the owner shall select competent and responsible contractors and select machinery that is properly built for the work by concerns with fixed and known responsibility.

There are of course many contractors who are not good business men, particularly the smaller contractors who do not keep their costs carefully, but these men as a

rule do not last very long and do not often appear in connection with the larger work. It is the duty also of the engineer in preparing specifications, not to ask for guarantees that are unreasonable and difficult of fulfillment. Guarantees are sometimes put into specifications to cover the engineers' oversights and carelessness in the preparation of his plans and specifications, and are usually, under such conditions, made very exacting, which means that the contractor adds considerable to his bid to take care of these guarantees and the guarantees in themselves have no real value to the owner.

The engineer should in the interest of the owner and for his own protection, make his plans and specifications definite, giving sizes throughout where it is possible to do so, and not require a lot of special conditions which should not obtain. He has no right to ask the contractor to guarantee other than workmanship and quality of materials furnished by him. The results to be obtained in a plant rests with the engineer and not with the contractor, and no engineer is justified in asking the contractor to guarantee a definite temperature of a heating system or a definite output from any apparatus designed by him, beyond what is known as the standard results that can be obtained from such apparatus. Neither has he any right to require that a plant shall be erected to his satisfaction. Satisfaction is a state of mind which is liable to change from day to day and cannot be determined by a specification or an inspection.

As far as possible omit general clauses that mean little or much as they may be interpreted, but insist that the specifications and plans have the same meaning after the contract is closed, that they did when bids were being taken. It is the duty of the engineer to make clear to the owner that no matter how carefully the plans are drawn, that without competent contractors, satisfactory results cannot be made certain, the contractor most desired being an honest man who knows his business.

One of the members of our Society asked me what determines, in the mind of the engineer, the kind of heating and ventilating system to be installed in any particular building, and what is the determining factor in the selection of the apparatus. This is a somewhat difficult and complex question to answer, but I will outline to you what seems to me to be the lines that should be followed:

1. The engineer must be fully acquainted with the use to which the building is to be put. I am assuming that the type of construction and all other structural details are already known to him, but the character of the occupancy and the business to be carried on in the building, is the first matter which would determine the type of the equipment to be installed.
2. The average number of people in the building and the hours of occupancy.
3. The amount of money that is available or can reasonably be expended on the plant.
4. The operating costs of the plant.

When the answers are received to these four general questions, the engineer is in a position to determine what

(Continued on page 56)



Technology Club of Philadelphia

D. K. BULLENS, Chairman

C. J. WALTON, Secretary
1421 Arch Street



AT the meeting of the Club on Wednesday evening, December 6, Mr. James Swan, of the New York Ship Building Company, gave a most interesting address on "Modern Shipbuilding." The lecture was illustrated with lantern slides and moving pictures.

On January 3 Mr. Lester B. Gardner, of New York, will speak on "Aviation."

The Technology Musical Clubs will give their annual

concert in Philadelphia on Saturday night, February 3, at the New Century Club. The concert will be followed by a dance. Every one is urged to give their hearty support. Tickets, one dollar each, may be obtained from the secretary or other officers of the Club.

H. LeR. Walker has been appointed to the Meetings Committee of the Engineers' Club, and D. K. Bullens to the Board of Directors.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

(Continued from page 55)

is the best type of equipment for the particular building under consideration. If the building is a warehouse or storage building merely and the object is to prevent freezing or give a reasonably comfortable temperature, then simple direct radiation is the answer. If the building is to house a considerable number of people, then the question of installing ventilation in connection with the heating system must be given consideration. If the building is occupied for a comparatively few hours, or say, not over eight hours of the twenty-four, and yet the building is required to be warmed the full twenty-four hours, then a tempered air supply in addition to direct radiation would be the natural answer to the question as to the system to be used, but it may be that the answer to the third question, as to the amount of money available, will prevent the separate system of direct radiation with the independent tempered air supply, and it is entirely possible that a blower system can be installed for less money and arranged so that at nights and on Sundays in very cold weather, it can be run at reduced speeds, simply to maintain temperatures, recirculating the air in the building during such hours of non-occupancy, instead of taking air from out-doors. After the plant is planned to satisfactorily meet the requirements of the building, and it is found that the cost must be reduced, it becomes very often a difficult question to determine where the pruning must be done. Apparently we cannot reduce the heating surface to too low a point because the average person is more interested in keeping warm than he is in getting fresh air. If it becomes necessary to cut out the ventilating system, provision should be made so that it can be later installed, or in some cases, it is possible to put in a partial system arranging it in such a way that it can be added to later to render more satisfactory service.

Through the entire problem runs the relationship of occupancy, hours of use, type of building construction, cost of plant, installation and operation, and each of these divisions must be kept before the engineer as the problem is developed, and before the final solution, each may be required to yield a percentage of its importance to achieve a harmonious whole. One point I particularly impress on

the members of our Society is to avoid over-refinements of heating and ventilating equipments where skilled attention is not possible. It is a mistake to install an elaborate system of heating and ventilation with temperature control, air washers, humidifiers and other refinements of the heating system unless the engineer is sure that after its installation, it will get proper and reasonable attention.

Just here, let me say a word on temperatures. It is the custom in this vicinity to base all our calculations on warming the average occupied building to 70° Fahr. with zero outside. It seems to me that it is time this requirement of the owners and architects was modified. All heating engineers and contractors know that zero weather for more than a few hours in any winter is unknown and often several winters pass without the temperature falling to that point. It is generally true also that when the temperature falls to zero, we have little or no wind. Why then should not a higher outside temperature, say, plus 10° Fahr. be the basis of calculations, and then when the occasional zero day arrives, force the heating apparatus to meet the conditions. In other words why figure a 100 per cent plant for the entire winter when an 85 per cent plant is sufficient for more than 99 per cent of the season when heat is required? I submit this for the consideration of the Chapter, in the interest of cost saving on the installation of heating apparatus in this section of the country.

In conclusion permit me to say that I believe it is the duty of the engineer to the owner and to himself, that the engineer shall make his plans and specifications definite and clear, and that he shall specify the materials wanted by name, size, quality; that he shall omit indefinite and arbitrary clauses and unreasonable guarantees, that he insist that competent bidders shall be selected of equal ability and responsibility, that he shall interpret the plans and specifications to require the same workmanship and materials from the contractor for the work that he required of the bidders on the work, no more and no less. When he has done this, he will find that all parties to the agreement will benefit and that his prestige as an engineer will be enhanced.

THE GAS ENGINEER OF THE LAST CENTURY

THE present lighting restrictions bring home to us in some degree the conditions under which our grandparents made their walks abroad after dark. The want of light in their case was not due to Government interference, but to the great cost of all illuminants. What this was at the commencement of the nineteenth century is not certain, but as late as 1841 Dr. Ure mentioned that sperm oil cost 9s. per gallon, and it is quite probable that this—the sole means of outdoor illumination—was still dearer at the beginning of the century. It is certain that street lights would be few and far between, while the troubles of the pedestrian would be increased by the poor paving, or entire want of paving, and by the frequent presence of footpads. No wonder that gas was received with enthusiasm, although one impecunious literary man lamented that it rendered it more difficult to avoid the sheriff's officers. The first street gas lighting in London was in 1804, and was followed by Parliamentary schemes in 1809–10–12–14 for the National Light and Heat Company, afterwards the Chartered Gas Company, now the Gas Light and Coke Company, of London. By 1827 the whole of the public oil lanterns of London were replaced by gas lamps. Probably these did not give very much light, judged by our present ideas, for the price of gas was originally 15s. per 1,000 ft., and from 1837 to 1849 it was 6s., as against 2s. 2d. in 1909. It is only fair to say, however, that the early gas was very rich, and that burners consuming 1 cub. ft. per hour satisfied a public accustomed to tallow candles.

The early progress of gas lighting was slow, mainly, we imagine, because the houses were not piped for its reception and that tenants and landlords each tried to put the expense on the other. We have seen the same struggle in recent years in connection with electric wiring. It could scarcely have been the quarterly bills which deterred householders, for they could not have exceeded the cost of tallow candles at 8d. per lb., or wax candles at 2s. 6d. per lb., unless the illumination had been greatly increased. Gasworks multiplied in London faster than the demand grew. In 1823 the output by the Chartered Gas Company was 660,000 cub. ft. daily, but there were several other companies. In 1837 the total annual consumption in the Metropolis was 1,600,000,000 cub. ft., and this doubled in the period 1837–1849. The amounts for the decennial periods 1869–79–89–99, 1909, were 9,885,000,000, 17,635,000,000, 20,649,000,000 34,057,000,000 and 38,300,000,000. In 1915 the consumption was 42,624,000,000 cub. ft.

Gas lighting was, of course, not confined to London, and in 1850 there were 750 established gas companies in the kingdom. These represented an immense amount of engineering work, both in the distillation of the coal and in the distribution of the gas. Prominent among the men who directed the progress of the art was Mr. Thomas Hawksley, who was engaged in the design of gasworks from 1830 to 1893. It was therefore very fitting that the Thomas Hawksley Lecture before the Institution of

Mechanical Engineers should this year be devoted to a recital of the work of the gas engineer of the last century.

The lecture was delivered last Friday (the 3rd inst.) by Mr. Harry E. Jones, whose long connection with the Gas Light and Coke Company of London rendered him peculiarly fitted to undertake the task. He selected three names, from a crowd of others, as specially worthy of note in connection with the rise and progress of the gas industry. These were Samuel Clegg, Thomas Hawksley and George Livesey. Clegg was both a capable engineer and an inventor; he was engaged in putting up gasworks under Murdoch as early as 1806, and as late as 1850 he was writing vigorously to the *Journal of Gaslighting* vindicating his claim to the invention of the wet meter. There is no doubt that he did more than anyone else to convert the early crude appliances into commercial plant capable of giving satisfactory service to the public. The invention of the wet meter, and of the hydraulic seal in retort mains, valves, purifier covers and gas holders, are all credited to Clegg. A very interesting and important figure, he stands out pre-eminent in practical work of value for the first 25 years of the development of gas.

When Hawksley began practice as a gas engineer much of the pioneer work was done, and it was in the arrangement of works as a whole, rather than in the perfecting of the individual appliances, that he engaged. No one who knew him needs to be told that his work was splendid, and that completeness, rather than economy, was the object he kept in view. Mr. Jones says that his early works were "of Roman endurance," due partly to nervousness on the part of the public on account of various explosions which had taken place, and largely, no doubt, to his natural tendency to eliminate every chance of breakdown. It must not be supposed, however, that Hawksley had in his early days only to assemble machinery already in the market. He had to teach his various contractors in all the specialties, such as retort setting, gas-holder and tank construction, as well as in purification plant. This involved a large amount of labour, and would have engrossed the whole attention of most men. But Hawksley is better known as a waterworks engineer than as a gas engineer, and in addition occupied a leading position as a sanitary engineer. His labours covered all phases of town life.

The third of the three great gas engineers is Sir George Livesey, who covers the period from 1865 to 1908. He was connected with the South Metropolitan Gas Company, and executed some of the largest works in existence. The East Greenwich Works, which he designed, have a daily output of 30,000,000 cub. ft. They comprise jetties, viaducts, wharf walling, deep tanks, and the loftiest gas-holders yet ventured upon in this country, extensive carbonising retort buildings and special purifying plant, a tar distillery, sulphuric acid works, and plant for following up all the ramifications and labyrinths of the enormous family of secondary by-products arising from gas manufacture. He encountered and conquered serious difficulties in deep foundations, sand pumping and grabbing

through water-bearing strata, and the construction of deep tanks in unstable water-logged soils, under heavy pressure from neighbouring main river channels. He is, perhaps, best known for his courage in fighting a gigantic strike, and for the wise statesmanship by which he subsequently reconciled labour to the interests of capital by a scheme of co-partnership, which comprised the admission of workmen to the board of directors. He devised the sliding scale for the price of gas, and effected the removal of many vexatious and useless restrictions on the manufacture imposed by Parliament. He put the industry on a new footing by insisting that the interests of the consumers and of the companies were, if not identical, at least not antagonistic.

We have, then, three very different types of engineers covering the period from 1806 to 1908, and representing also the advance of engineering science and practice in that period. First, we have the mechanic and inventor who worked out the plant from its early crude condition into one of practical use. Next comes the scientific engineer, who put the manufacture on to a sound commercial basis. He was the servant and friend of the capitalist, piloting his schemes through Parliament, and then giving them a material existence in which they would be certain to earn steady dividends. Finally comes the engineer-statesman, who was not only an engineer of things, but also an engineer of men. He moulded the laws and social usages of his time, and left the body politic in a condition to work more sweetly and efficiently than he found it. Livesey's economic achievements have somewhat obscured his work as an engineer. That alone would have been a monument for most men, for nearly everything he did was a step in the dark. It was not only that his construction in gas plant and works were larger than their predecessors, but they exemplified novel principles, and required not only great engineering knowledge for their design, but, what is more rare, moral courage of a high order for their construction.

As to the numerous other engineers who deserve honourable mention, in connection with the gas industry we must refer our readers to Mr. Jones's lecture, which will be printed in the Journal of the Institution. They will there find a very valuable record of the rise and progress of gas lighting, and of the men who took part in it. We cannot help feeling, however, that the monopoly which the industry enjoyed, valuable as it was in the early years, had a deadening tendency in the middle of the century, and that progress would have been more rapid had it earlier felt the stimulus of competition. From 1804 to 1850, when Young introduced paraffin oil, gas had no more serious competitors than the candle and the sperm oil lamp. The discovery of petroleum in large quantities in America was an enormous boon to the poor and to dwellers in the country. But it did not greatly affect the sale of gas in towns, and the monopoly was not seriously threatened until the advent of electric light. The lighting of the Avenue de l'Opera in Paris by the Jablochhoff candle in 1878 sent a cold shudder down the back of the

gas shareholder, while acting as a tonic to the gas engineer. Before that date scientific discovery had generally strengthened the position of the gas company. The discovery of the aniline dyes in 1858 and the great appreciation of the value of ammonia as a manure some years later had increased the value of residuals enormously, and had rendered efforts at economy of manufacture a counsel of perfection. The introduction of the Swan lamp about 1880 entirely reversed this process. Since then one improvement has followed another in rapid succession, the last 20 years of the century seeing the introduction of the Welsbach incandescent mantle, the penny-in-the-slot meter, new methods of purification, high-pressure mains, in addition to numerous improvements in the works. The gas engineer has certainly fought a strenuous battle on behalf of his shareholders, and there is every prospect that in the twentieth century he will more than rival the achievements of his predecessors in the century dealt with in Mr. Jones's interesting lecture.—*Engineering.*

ROAD-TESTING INDOORS—VALUE OF A NEW MACHINE

VALUABLE results have been obtained from testing road materials by means of a special machine at the Road Board Laboratory. In this machine, according to the annual report of the Board, road material is laid down as if it were part of an actual roadway, and subjected to the rolling, hammering, and abrasive action of loaded wheels driven over it at speed. This mode of testing, which was started in 1913, affords in some respects a more accurate means of comparison than is possible when the material is laid in the open and exposed to varying conditions. The machine consists of a revolving frame supported on wheels running on a circular test path, which is 34 feet in diameter and has a working width of 2 feet. The road material is laid down on a concrete foundation, and the machine revolves at any desired speed on the surface to be tested. The road machine framework is supported by eight wheels 3 feet 3 inches diameter and 3 inches tyre width; each wheel is driven by its own motor, and the action on the test surface is nearly the same as that of a driving wheel of a motor lorry loaded to the same weight. In most cases the weight per inch of tyre width has been about 470 lbs., but this has sometimes been increased to 750 lbs.—approximately the maximum allowed by the Local Government Board regulations. The test surface may be kept perfectly dry or be sprayed to any degree of wetness. During a wet test—the usual standard of comparison—all the material worn off by attrition can be collected and weighed, and thus the loss of material from wear can be accurately measured. The temperature of the test room can also be maintained at any desired point.—*Indian Engineering.*

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ENGINEERS' CLUB

NOTICE

THIS COLUMN IS SCORED TO MAKE IT CONVENIENT TO TEAR OUT FOR READY REFERENCE IN YOUR POCKET OR ON YOUR DESK.

MEETINGS

JAN. 8 AMERICAN INSTITUTE ELECTRICAL ENGINEERS.—Commercial Engineering. By C. J. Russell, Philadelphia Electric Company.

JAN. 9 ENGINEERS' CLUB.—Meeting of Board of Directors.

JAN. 11 AMERICAN SOCIETY HEATING AND VENTILATING ENGINEERS.

JAN. 16 REGULAR MEETING to be held at Witherspoon Hall.—"Chemical Research in Philadelphia." By Dr. Edgar Fahs Smith, Provost, University of Pennsylvania.

JAN. 19 ILLUMINATING ENGINEERING SOCIETY.

JAN. 22 JUNIOR MEETING at Engineers' Club. Subject, "Organization of the Bureau of Surveys."

JAN. 23 AMERICAN SOCIETY MECHANICAL ENGINEERS.

JAN. 25 SOCIETY AUTOMOBILE ENGINEERS.

JAN. 26 MEETING OF ENGINEERS' CLUB to be held at Drexel Institute. "The Zoning System." by Hon. Edward M. Bassett, Chairman of the Heights of Buildings Commission, and Chairman of the Commission of Building Districts and Restrictions, New York City.

FEB. 5 AMERICAN SOCIETY CIVIL ENGINEERS.

FEB. 7 TECHNOLOGY CLUB OF PHILADELPHIA.

FEB. 8 AMERICAN SOCIETY HEATING AND VENTILATING ENGINEERS.

FEB. 12 AMERICAN INSTITUTE ELECTRICAL ENGINEERS.

FEB. 13 ENGINEERS' CLUB.—Meeting of Board of Directors.

OFFICIAL NOTICE

REGULAR MEETING—January 16, 1917, to be held at Witherspoon Hall.

"Chemical Research in Philadelphia." By Dr. Edgar Fahs Smith, Provost, University of Pennsylvania.

MEETING OF ENGINEERS' CLUB—January 26, 1917, to be held at Drexel Institute.

"The Zoning System." By Hon. Edward M. Bassett, Chairman of the Heights of Buildings Commission, and Chairman of the Commission of Building Districts and Restrictions, New York City.

ROBERT H. FERNALD, Secretary.

OF PHILADELPHIA

INDEX TO ADVERTISERS

Name	Page
Albright & Mebus	22
Alan Wood Iron and Steel Co.	58
American Pipe and Construction Company	45
American Pulley Co.	
Atlantic Refining Company, The	
Autocar Company	42
Baldwin Locomotive Works, The	54
Ballinger & Perrot	22
Barber Asphalt Paving Company, The	57
Barr, Robert M.	22
Berryman Co., Robert J.	22
Bonine, Charles E.	22
Caccavajo, Joseph	22
Cement Gun Company, The	50
Chance & Co., H. M.	22
Conard, Wm. R.	22
Colby & Christie	22
Crew Levick	61
Day & Zimmerman	22
DeFrain Sand Company, The	61
Dyer, W. E. S.	22
Elcock, John J.	22
Gatchel & Manning	58
Hand, Morgan, Jr.	22
Hetherington Motor Company	53
Jackson, Wm. Steell	22
Jellett Co., Stewart A.	22
Keystone Lubricating Company	29
Lehigh Coal & Navigation Co.	50
Lewis, Robinson & Grant	64
Link-Belt Company	Outside back cover
Lippincott Company, J. B.	41
Lippincott Company, J. B.	Inside back cover
Lupton's Sons Company, David	38
Moon, T. Elmer	22
Moore & White Company, The	45
Mormann, Geo.	22
Nelson Valve Company	49
Otto Gas Engine Works, The	53
Parker, E. H.	22
Phoenix Portland Cement Company	57
Phosphor-Bronze Smelting Co.	50
Rexim Company	
Richardson & Boynton Co.	64
Rooksby & Company, E. J.	58
Royersford Foundry and Machine Company	46
Sanville, H. F.	22
Sauer & Company, Andrew J.	22
Scofield Engineering Company	22
Shannon & Co., J. Jacob	54
Smith, Edwin F.	22
Stewart Electric Company, Frank H.	58
Third National Bank	
Transmission Ball Bearing Company, ...	37
Underwood & Company, H. B.	34
United Gas Improvement Company.	33
Walters, L. B.	30
Wilson Corporation, J. G.	63
Wood, Albert C.	22
Yarnall-Waring Company	49

Foreign Notes

Continued from page 46

to be placed in the central plane. A balance weight placed in the middle between the two motors would have been simpler still; but that modification would have called for a replacement of the shafts and flywheels. The first-mentioned arrangement was hence decided upon and carried out by the Lokomotivfabrik Winterthur. So far, we see from the *Schweizerische Bauzeitung* of September 23, this has been done only in the case of the one motor. But as the vibrations have been reduced to a minimum, although the motor is once more run at the original speed of 180 revolutions, the solution of the problem is considered to have been successful.—*Engineering*.

Industrial Notes

IN a room 2 feet $\times$ 6 feet (more or less) in an office building, L. B. Walters, a member of the Club, does more business in automobile tires than many of the tire dealers who have elaborate show windows on Broad Street. As the official headquarters for tires for the Delaware County Automobile Club and other associations, his office not only takes care of the tire needs but also handles all the details required for securing owners' and drivers' licenses and tags. Sometimes as many as 400 tires of all makes are shipped through Mr. Walters' office in a day and very seldom does the daily average fall below 100 tires. The practice of Mr. Walters not to make any charge for notary fees, etc., in connection with the applications for auto licenses has given him plenty of additional work to do, but it has also added greatly to his host of friends and clients.

THE fifth furnace at the Belmont plant of the Link-Belt Company, Indianapolis, was blown in the middle of December, adding materially to the capacity for producing malleable Link-Belt. Extensive building operations at the Belmont works have been completed, and the manufacturing activities reorganized to keep pace with the increasing demand for Link-Belt for all conveying, elevating and power transmission purposes.

PROCEEDINGS OF THE ENGINEERS' CLUB OF PHILADELPHIA

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CONTENTS OF THIS ISSUE

	PAGE		PAGE
Officers, Directors, Standing and Special Committees of Engineers' Club.....	66	American Society of Mechanical Engineers.....	91
		February Meeting—Philadelphia Section	
Editorial.....	67	American Institute of Electrical Engineers.....	92
Committee on Papers.....	68	January-February Joint Meeting, February Regular Meeting.	
Announcement by LEWIS H. KENNEY, Chairman		American Society of Heating and Ventilating Engi- neers.....	92
Secretary's Notices.....	69	Regular Meeting, Jan. 11	
Business Meeting of The Club, Jan. 16, 1917		Illuminating Engineering Society.....	93
Regular Meeting Board of Directors, Jan. 9, 1917		Regular Meeting, Philadelphia Section	
Committee on Membership.....	71	Engineering Articles of General Interest.....	97
Candidates for Membership		Care of Marine Boilers. By EDWARD B. FRASER	
The Department of Wharves, Docks and Ferries, of the City of Philadelphia.....	73	The Manufacture of Armature Coils. By D. W. PERRY	
Obituary.....	78	Russian Petroleum—Eight Months of 1916	
OTTO C. WOLF		Origination versus Imitation in Design. By R. H. M.	
Professional Directory.....	80	Removing Coenties Reef from the East River, New York.	
Economics of Power Plants.....	81	By EDWARD H. DION	
By FRANCIS R. WELLER, Consulting Engineer.		Water for Steam Boilers—Its Significance and Treatment.	
Positions Vacant.....	88	By ARTHUR C. SCOTT and J. R. BAILEY	
Technology Club of Philadelphia.....	89	Foreign Notes.....	108
Regular Meeting, Jan. 3, 1917		The Mystery of Metals	
The Cause, Prevention and Cure of Disease by Bacteria.		Philadelphia Association of Members of the Ameri- can Society of Civil Engineers.....	110
By C. LEON COWLES.		Industrial Notes.....	110
Society of Automobile Engineers.....	90		
The January Meeting.			
Power Losses in Pneumatic Tires.			

Permission is given to reprint any paper after its date of presentation, provided proper credit is given.

Contributions of all kinds on all topics of interest to the members of the Engineers' Club are cordially invited. All matter for publica-
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Engineers' Club of Philadelphia

Officers and Directors, 1915

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EMMETT B. CARTER

SECRETARY

ROBERT H. FERNALD

TREASURER

W. M. IRISH

VICE-PRESIDENTS

J. A. VOGLESON
D. ROBERT YARNALL
J. H. M. ANDREWS

DIRECTORS AT LARGE

J. F. MURRAY
JOSEPH C. WAGNER

PAST PRESIDENTS

W. P. TAYLOR
S. M. SWAAB
J. W. LEDOUX

DIRECTORS

JOSEPH H. TRACY (A. I. E. E.)
J. E. GIBSON (A. S. M. E.)

E. B. TEMPLE (A. S. C. E.)
G. S. CRAMPTON (I. E. S.)
J. D. CASSELL (A. S. H. V. E.)

D. K. BULLENS (M. I. T.)
B. B. BACHMAN (S. A. E.)

Standing Committees

FINANCE

J. F. MURRAY, Chairman
W. M. IRISH
HENRY HESS
H. A. MOORE
E. B. TEMPLE

PUBLICATION

J. A. VOGLESON, Chairman
S. M. SWAAB
E. S. FOLJAMBE
J. W. LEDOUX
JOHN P. MUDD

HOUSE

J. H. M. ANDREWS, Chairman
W. P. TAYLOR
H. P. GANT
G. S. CRAMPTON
HERBERT RICE

MEETINGS

J. C. WAGNER, Chairman
J. A. VOGLESON
H. P. LIVERSIDGE (A. I. E. E.)

J. A. STEINMETZ (A. S. M. E.)
C. O. BOND, (I. E. S.)
E. B. TEMPLE (A. S. C. E.)

H. Le R. WALKER (M. I. T.)
N. S. PRINGLE (S. A. E.)
GEORGE W. BARR (A. S. H. V. E.)

MEMBERSHIP

D. ROBERT YARNALL, Chairman
J. E. GIBSON
J. F. MURRAY
R. H. FERNALD
H. GOODWIN, JR.

TRUSTEES

BOND REDEMPTION FUND

HENRY LEFFMANN
EDGAR MARBURG
EDWIN F. SMITH

Special Committees

PAPERS

LEWIS H. KENNEY, Chairman
J. C. WAGNER

H. P. GANT
W. M. BOEHM
J. A. STEINMETZ
G. M. SPEAR
WM. POOL PARKER
H. F. SANVILLE
D. KNICKERBACKER BOYD
W. G. BROOKS

PUBLIC RELATIONS

GEORGE R. HENDERSON, Chairman
EDGAR MARBURG

CHARLES F. MEBUS
H. F. SANVILLE (A. I. E. E.)
STAUNTON B. PECR (A. S. M. E.)
GEO. S. WEBSTER (A. S. C. E.)
C. J. WALTON (M. I. T.)
THOMAS SPROULE (I. E. S.)
W. W. RICE (A. S. H. V. E.)
W. H. PALMER (S. A. E.)

BY-LAWS

J. F. STEVENS, Chairman
ROBERT H. FERNALD
JOHN C. TRAUTWINE, JR.
JONATHAN JONES
ROBERT M. BARR

LIBRARY

F. C. DUNLAP, Chairman
CHAS. F. PUFF, JR.
JOHN S. ELY
MANTON E. HIBBS
J. B. McCORD
CHAS. H. FROMMER
WM. H. BOARDMAN

PUBLICITY

S. M. SWAAB, Chairman
J. H. M. ANDREWS
W. P. TAYLOR
JOS. A. STEINMETZ
LEWIS H. KENNEY

TELLERS

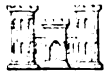
G. E. CROFOOT, Chairman
JOHN P. MUDD
HAROLD GOODWIN, SR.

ALTERNATE TELLERS

CHARLES PENROSE, Chairman
JOHN S. ELY
CHAS. F. PUFF, JR.

SECRETARY TO THE SECRETARY

S. M. SNEDEKER



Editorial



OUR National Engineering Societies responded very readily to the request of the Government for their aid in solving the engineering problems of the Army and the Navy. That our Club is willing to assist is evidenced by over 400 members recently volunteering to aid the Naval Consulting Board in inventorying the industries and resources of the State of Pennsylvania in order that the Army and the Navy Departments might have accurate information as to where needed military supplies could be obtained.

Our Club has been interested in Company "B" Engineers which was mustered into the National Guard of Pennsylvania at the Club House in January 9th, 1909, because the majority of the members of the Company were members of the Club. The duties of engineer troops are clearly defined in a recent bulletin issued by the War Department which states: "The duty of engineers is to apply engineering science to the emergencies of modern warfare in order to protect and assist troops, to ameliorate the conditions under which they are serving, to facilitate locomotion and communication, and whenever the occasion requires to act as purely combatant troops."

The services rendered the Government by our National Engineering Societies must be supplemented by the local engineering societies supporting our technical troops.

That the War Department appreciates the interest our Club has taken in Company "B" is shown by the following quotation from a recent report: "To be a success a National Guard organization must have the support of the home community, and in branches of the service which are technical, such as engineer, medical and signal troops, the support of the local profession must be secured to demand respect. Engineering societies exist in almost every community—cities principally—in which engineer troops can be maintained. It is essential that the officers be men of standing in the engineering profession. . . ."

"It is believed, therefore, that the greatest step toward securing a reliable National Guard force is to require as early as is practicable a conformance to the principle; in other words, get the engineering profession in every large city behind its local organization. The satisfactory showing made by Company 'B,' Pennsylvania Engineers, at the recent mobilization demonstrates the value of such support, for it was organized principally from members of the Engineers' Club of Philadelphia and has had the recognition and support of that organization."



The Publication Committee announces that Vol. XXXIV will be paged continuously throughout the year to permit of binding in a more convenient form.

The change is made, too, in full confidence that it will meet with the approval of the readers.

Engineers' Club of Philadelphia

COMMITTEE ON PAPERS

LEWIS H. KENNEY, Chairman

ANNOUNCEMENT

MEETING OF FEBRUARY 20, 1917, at THE ENGINEERS' CLUB

THE meeting, announced in the January PROCEEDINGS, to be held at Witherspoon Hall, February 20, has been cancelled.

After the business meeting of the Club for the discussion on the proposed By-Laws, several reels of motion pictures will be shown.

PRELIMINARY ANNOUNCEMENT

Preliminary announcement is made of the following meetings for the information of the membership. More detailed information will appear in the next issue of the PROCEEDINGS.

MARCH 20, 1917.—*Regular Club Meeting, at Witherspoon Hall.* The paper of the evening, "The Panama Canal," will be presented by **Brigadier-General George W. Goethals, U. S. A.**

MARCH 26, 1917.—*Junior Meeting at Engineers' Club.* Subject: "Organization of the Bureau of Highways."

MEETINGS FOR JUNIOR MEMBERS

Dr. W. M. Boehm, member of the Committee, has been elected Chairman of the meetings. Attendance at the meetings will be limited to Junior Members and their guests, and Officers and Senior Members invited by the Committee on Papers.

FEBRUARY 26, 1917.—*Meeting at the Engineers' Club.* Subject: "The Bureau of Surveys of the City of Philadelphia." (Illustrated.)

1. ITS ORGANIZATION AND DUTIES.
SOME RECENT BRIDGES.
By **Wilmer Z. Kline.**
2. SOUTH PHILADELPHIA IMPROVEMENTS.
By **Samuel Mustin.**
3. THE PROBLEM OF SEWAGE DISPOSAL.
By **Malcolm Orr.**

Junior members are privileged to invite friends to the meeting.

PRIZE FOR JUNIOR MEMBERS

See November issue of PROCEEDINGS, Page 5, for rules governing the award of prize for Junior Members.

All papers must be submitted to the Committee on Papers, on or before March 31, 1917.

Engineers' Club of Philadelphia

SECRETARY'S NOTICES

A BUSINESS meeting of the Club will be held Tuesday evening, February 20th, 1917, at 8.15 o'clock, at the Club house, to consider the proposed amendments to the By-Laws, in accordance with the provisions of Article XII.

Copy of present By-Laws and proposed Amendments has been sent to the members.

ROBERT H. FERNALD
Secretary.

REPORT OF THE TELLERS ON THE VOTE TO AMEND ARTICLE XII OF THE BY-LAWS

In accordance with the motion passed at the Business Meeting of the Club on January 16, 1917, the report of the Tellers on the vote to amend Article XII of the By-Laws is as follows:

"Mr. President and Members of
The Engineers' Club of Philadelphia.

GENTLEMEN:

Your Tellers have counted the ballots cast for and against the amendment to Article XII of the By-Laws, and declare that 40 legal ballots were cast, as follows:

For the amendment, 38.

Against the amendment, 2.

Respectfully submitted,

(Signed) GEORGE E. CROFOOT,
HAROLD GOODWIN, JR.
JOHN P. MUDD."

The following amendment is therefore declared adopted:

Article XII AMENDMENTS

1. Proposed amendments to these By-Laws may be submitted directly to the Club by the Board of Directors, or may be presented in writing to the Board of Directors, signed by at least twenty-five Active Members in good standing, and, if so presented, shall be reported by the Board with its recommendations, at the next Business Meeting of the Club before which such business may properly come. The notice of the said meeting shall give the wording of the proposed amendment, and shall state that it may then be discussed and amended.

2. The proposed amendment shall be submitted for letter ballot within ten days from the meeting. Ballots to be considered shall be written or printed, and received through the mail or otherwise by the Tellers, not later

than ten days before the next meeting of the Club, at which meeting the Tellers shall report the result of the ballot.

3. Any amendment for which two-thirds of the ballots received are in the affirmative shall be adopted.

ROBERT H. FERNALD,
Secretary.

ABSTRACT OF MINUTES OF THE BUSINESS MEETING OF THE CLUB

HELD TUESDAY, JANUARY 16, 1917.

The meeting was called to order by Vice-president Yarnall at 8.15 P.M. About 400 members and guests were in attendance.

The minutes of the Regular Meeting of November 21, 1916, the Special Meeting of December 13, 1916, and the Business Meeting of December 19, 1916, as printed in the PROCEEDINGS, were approved.

Owing to the fact that the Tellers were unable to make a report on the vote on amendment to Article XII of the By-Laws without holding the members present beyond a reasonable length of time, the Club voted to receive the report through publication in the February number of the PROCEEDINGS.

The paper of the evening, entitled "Chemical Research in Philadelphia," was presented by Dr. Edgar Fahs Smith, Provost of the University of Pennsylvania.

The meeting adjourned at 9.45 P.M.

ROBERT H. FERNALD,
Secretary.

ABSTRACT OF MINUTES OF THE REGULAR MEETING OF THE BOARD OF DIRECTORS

HELD JANUARY 9, 1917

The meeting was called to order by President Carter at 8.15 P.M., with Vice-presidents Vogleson, Yarnall and Andrews, Directors Murray and Crampton, Past Presidents Taylor and Swaab, Secretary Fernald and Treasurer Irish in attendance. Directors Wagner, Liversidge, Gibson, Bachman and Past President Ledoux were excused. Directors Temple, Foljambe and Cassell were absent.

The minutes of the Regular Meeting of December 12, 1916, as issued to the Board of Directors, were approved.

REPORT OF THE PRESIDENT

The President announced that he had found it necessary to reappoint the Committee to secure Club Manager, and asked for ratification of this action.

ENGINEERS' CLUB OF PHILADELPHIA

Action: Reappointment of Committee ratified.

The President stated that he had received a letter from Mr. Yarnall, suggesting that the Club hold a subscription banquet.

Action: President authorized to appoint a Committee of five, with power to act, to investigate the question.

The following Committee was appointed:

D. Robert Yarnall, Chairman	George S. Crampton
Robert H. Fernald	Harold Goodwin, Jr.
(fifth member to be appointed)	

REPORT OF THE SECRETARY

The following resignations from members in good standing were presented:

James B. Douglas	Arthur Kuppinger
Neilson Edwards	R. A. Robinson
W. C. Hammond	Wm. C. Wetherill
L. Walter Israel	Ralph E. Young

Action: Resignations accepted as of March 31, 1917.

The death of Mr. Otto C. Wolf, on December 19, 1916, was announced. The Secretary stated that biography had been sent to the Committee on Publication.

The Secretary asked for authority, in the absence of a Business Manager, to approve for payment vouchers, petty cash slips, etc.

Action: The Secretary was empowered to certify to these various accounts, in the absence of the Business Manager, authority to take effect as of January 1, 1917.

REPORT OF THE TREASURER

The Treasurer presented a report, which was accepted.

REPORT OF THE COMMITTEE ON FINANCE

The Committee presented a report on the finances of the Club, which was accepted.

REPORT OF THE COMMITTEE ON HOUSE

The Chairman reported that the number of meals served during the month was 2432, an increase of 89 over the preceding month. 1076 dinners, 1089 luncheons and 277 breakfasts were served.

The Chairman further stated that, owing to the resignation of the Business Manager, Mr. F. G. Meily was assigned to charge of the dining-room and kitchen, due to his previous experience in this line of work.

Action: Report of the Committee accepted.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The Chairman reported that the Committee met and passed upon ten applications for membership, but, due to the fact that the January Proceedings, in which will appear the names of these applicants, had not yet been issued, it would be necessary to postpone the election until the February Board meeting.

REPORT OF THE COMMITTEE ON PUBLICATION

The Chairman presented a report, which was accepted.

REPORT OF THE COMMITTEE ON PAPERS

The Committee submitted a report, stating that arrangements were being made for exhibition of maps and models in connection with the meeting of the Club on "The Zoning System," to be held at the Drexel Institute, January 26, and requesting an appropriation of \$50.00 to cover possible expense involved in making these arrangements.

Action: At the suggestion of Mr. Yarnall, Chairman of the Committee on Membership, such portion of the \$50.00 appropriation to the Committee on Membership as is necessary to take care of the expense of the January 26 meeting, was transferred to the Committee on Papers, subject to the approval of the Committee on Finance.

COMMITTEE ON PUBLIC RELATIONS

The Committee submitted a report, stating that the resolution in favor of the adoption of the Centigrade Scale had been adopted by the Club at its meeting, December 19, 1916.

Action: Report accepted.

COMMITTEE TO SECURE CLUB MANAGER

The Chairman had no special report to offer, but stated that a meeting of the Committee would be held on January 10, and that it was hoped that a Manager would be secured by February 1. He further stated that a conference was had with Mr. Lewis H. Kenney, who is familiar with the details of the Club, and that Mr. Kenney had very kindly agreed to look after the meetings of affiliated societies held at the Club, during the absence of a Club Manager.

Action: A unanimous vote of thanks was extended to Mr. Kenney for his services at this time.

COMMITTEE ON BY-LAWS

The Committee submitted a report, stating that the proposed amendment to Article XII of the By-Laws had been accepted, without alteration, at the meeting of the Club on December 19, 1916.

Action: Report accepted.

COMMITTEE ON CLUB DEVELOPMENT

The Chairman of the Committee presented a report submitting plans and estimates prepared by Mr. Plack, member of the Committee, for work in connection with the proposed alterations to the present ladies' dining-room and an extension to be built in the present conservatory, to be used as an additional dining-room. He stated that these proposed alterations would not interfere in any way with any larger plan of extension which might take place later.

Action: Report accepted, and the Committee empowered to receive bids and to report at the next meeting of the Board.

Engineers' Club of Philadelphia

COMMITTEE ON MEMBERSHIP

D. ROBERT YARNALL, Chairman

CANDIDATES FOR MEMBERSHIP

Members having knowledge of the candidates are invited to submit to the Committee on Membership before February 12th a confidential expression of opinion as to the eligibility of the candidates; all communications to be addressed, "Chairman of the Committee on Membership, Engineers' Club, Philadelphia," marked "Confidential."

All applications are on file at the Club and can be referred to by any member.

FOR ELECTION TO ACTIVE MEMBERSHIP

WILLIAM Y. BORRESEN

3344 Germantown Ave., Phila., Pa.
Assistant Manager, Special Dept., Ford & Kendig Co.
Proposed by William Kohn, Jr., and C. F. Iszard.

H. R. COBLEIGH

49th and Market Sts., Phila., Pa.
Technical Editor, Automobile Trade Journal and Commercial Car Journal. Also a partner with Walter N. Polakov in the Power Plant Management Co., New York.
Proposed by Emmett B. Carter and R. H. Fernald.

HENRY LAWRENCE DOWELL

University of Pennsylvania, Engineering Dept., Phila., Pa.
Instructor, Mechanical Engineering, U. of P.
Proposed by George E. Crofoot, J. V. Stanford and R. H. Fernald.

CONARD MILLER GILBERT, JR.

118 N. 11th St., Phila., Pa.
Secretary, Treasurer and General Manager, in charge of engineering work Pre-Heated Air Co., 118 N. 11th St., Phila., Pa.
Proposed by Arthur C. Jackson and Wm. Steell Jackson.

ROBERT D. HAWKINS

112 Swarthmore Ave., Ridley Park, Pa.
Instructor in Mechanical Engineering, Univ. of Penna.
Proposed by Geo. E. Crofoot, J. V. Stanford and R. H. Fernald.

NELSON D. HERST

7956 "B" Street, Phila., Pa.
Chief Engineer, Industrial Cold Storage & Warehouse Co.
Proposed by A. F. Rader and George M. Spear.

ERIC LEONARD LUNDGREN

2342 N. 13th St., Phila., Pa.
Engineering, Osbourn & Co., 34 S. 17th St., Phila., Pa.
Proposed by J. H. R. Hagemans and Millard P. Osbourn.

JOHN GRIFFITH MAGUIRE

Swarthmore, Pa.
Power Sales Dept., Phila. Elec. Co.
Proposed by H. Goodwin, Jr., and D. Frederick Schick.

WALTER S. MILLER

2934 N. 26th St., Phila., Pa.
Structural Draftsman, Dept. Wharves, Docks and Ferries, City of Phila.
Proposed by Frank J. Sepas, Norman L. Stamm and Geo. S. Webster.

WILLIAM PETERS

1934 North Front St., Phila., Pa.
Engaged in the manufacturing of fire prevention devices and appliances, under the firm name of James Peters and Son.
Proposed by Chas. F. Puff, Jr., Hugh M. Wilson and Jos. C. Barnard.

GEORGE C. SOUDER

214 E. Orange St., Lancaster, Penna.
In firm of Souder Construction Co., Inc.
Proposed by C. B. Filbert, J. Reese Bailey and Edwin Smith.

ALEXANDER G. SPENCER

In care of Tindel-Morris Co., Eddystone, Pa.
Sales Dept., Tindel-Morris Co.
Proposed by D. K. Bullens and J. E. McKee.

FOR ELECTION TO JUNIOR MEMBERSHIP

HARRY B. FLOYD

2137 N. Uber St., Phila., Pa.
Engineering Clerk and Rodman, Pennsylvania Railroad Co.
Proposed by John F. Rowland and C. Raymond Larkin.

STANLEY LEVY

5122 DeLancey St.
Electrical Engineer, Western Electric Co., Phila., Pa.
Proposed by Charles C. Bream and Charles Elcock.

EARL MORTIMER NEWLIN

5243 Walnut St., Phila., Pa.
Inspector, Distribution Dept., Phila. Electric Co.
Proposed by H. Goodwin, Jr., D. Fred'k Schick.

Department of Wharves, Docks and Ferries

DIRECTOR GEORGE S. WEBSTER AND HIS PRINCIPAL ASSISTANTS



LEONARD WORK
ELECTRICAL &
MECHANICAL ENGINEER



GEORGE S. WEBSTER
DIRECTOR OF DEPARTMENT WHARVES, DOCKS
AND FERRIES



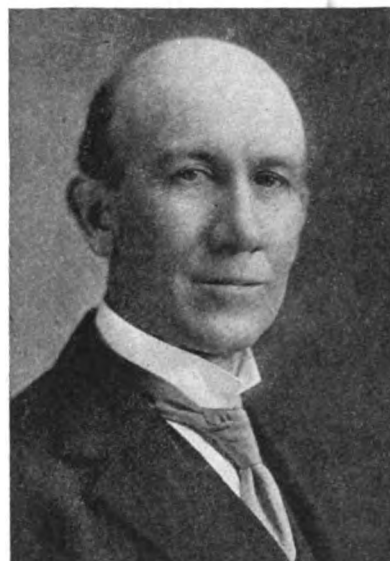
JOSEPH F. HASSKARL
ASSISTANT DIRECTOR, DEPARTMENT
WHARVES, DOCKS AND FERRIES



WM. K. JOHNSON
SECRETARY
DEPT. W. D. & FERRIES



JOHN GWILLIAM
ASSISTANT ENGINEER



ATWOOD L. BLISS
STATE ENGINEER



NORMAN L. STAMM
HARBOR ENGINEER



CHESTON M. BRYANT
C. E. DOCKMASTER



JOHN DOWNHAM
ASSISTANT ENGINEER



WALTER S. MILLER
DRAFTSMAN



CARROLL W. SIMON
ASSISTANT ENGINEER



HENRY F. COOK
INSPECTOR



JAMES F. MCGARITY
INSPECTOR



GEORGE GRAHAM
INSPECTOR



J. BENNETT COLESBERRY
DRAFTSMAN

The Department of Wharves, Docks and Ferries, of the City of Philadelphia.

Mr. Webster, the director, and his assistants have gone to considerable trouble to prepare an article dealing with their activities. Photographs have, in most cases, been prepared specially for this paper, and the editors desire to thank them for their trouble in presenting the article to us.

ALL over the world, as if moved by a common impulse from a common source, Nations of the first rank are showing a remarkable concentration of attention and expenditure upon the development of deeper channels and larger dock facilities.

In 1907, the Legislature of Pennsylvania, recognizing the importance of the growing commerce of the Commonwealth and the substantial improvements made by the Government of the United States in the channel-ways of our rivers and harbors, thought it desirable to enlarge and extend the powers given the City of Philadelphia for the control and development of its Port, the care and improvement of which up to that time had been under the jurisdiction of the Bureau of Surveys, Department of Public Works. Accordingly, an Act was passed creating the Department of Wharves, Docks and Ferries—a Municipal Department—to have sole charge of all port and harbor problems, and to be under the control of a Director to be appointed by the Mayor of the City, the present incumbent being Mr. George S. Webster, who assumed office on January 4, 1916, after having been for twenty-four years Chief Engineer of the Bureau of Surveys of said City; and an Assistant Director to be appointed by the Director, the present incumbent being Mr. Joseph F. Hasskarl, who for a number of years was Principal Assistant Engineer attached to the United States War Department in charge of the improvements of the Harbor of Philadelphia, and who was also a former Director of the Department.

The Department of Wharves, Docks and Ferries has charge, control and supervision of:

First: All wharf and storage property belonging to the City; has the power to regulate, fix and establish Bulkhead and Pierhead Lines, and the distance between piers, subject to the regulations of the United States Government; and to adopt and promulgate rules and regulations for the construction, extension, alteration, improvement and repair of wharves, piers, bulkheads, docks, slips and basins within the limits of the City.

Second: The preparation of studies and plans, awarding of contracts, the purchase and condemnation of property, supervision of construction, extension, alteration and repairs to wharves, piers and bulkheads, and all other harbor work belonging to the City, as well as the issuance of permits and licenses and general supervision of all private work of water-front improvements.

Third: The dredging of all city-owned docks into which city sewers empty along the Delaware and Schuylkill River fronts,—the maintenance and deepening of the channel of the Schuylkill River, and the maintenance and operation of the City Dredging Plant.

Fourth: The maintenance and operation of the City Ice Boat fleet in the Port of Philadelphia, and the patrolling of the Delaware River and Bay from Philadelphia to the sea during the ice season.

It has under its control property to the value of approximately \$11,573,000, divided as follows:

Land, structural and non-structural improvements, approximately	\$10,500,000
Floating Plant, approximately	1,000,000
Other equipment, approximately	73,000

For the purpose of convenience the organization of the Department is separated, by official consent, into Three Divisions, as follows:

First: The Division of Office Administration, having charge of accounts, contracts, issuance of permits and licenses and general office work, under the direct supervision of the Secretary.

Second: The Division of Engineering, having charge of the preparation of plans and estimates, making of surveys and examinations, the construction and maintenance of all piers, wharves, bulkheads and other land structures belonging to the Department, contract dredging, and the general supervision of all construction work, both Municipal and private, under the direct supervision of the Harbor Engineer.

Third: The Division of City Ice Boats and Dredges, having charge of the maintenance and operation of the Municipal Ice Boat Fleet and Dredging Plant, under the direct supervision of the Superintendent of Floating Plant.

The first division, that of Office Administration, has been under the direct supervision of Secretary William K. Johnson since the organization of the Department in 1907. Its duties, being of a routine nature, will not be enlarged upon in this paper. It is mentioned in this connection to show the different divisions of the Department.

The second division, that of Engineering, has been under the direct supervision of Harbor Engineer Norman L. Stamm (who had for several years previous been connected with the Bureau of Surveys) since May 1, 1911,

ENGINEERS' CLUB OF PHILADELPHIA

and has reached a degree of efficiency equal to that found in the largest industrial plants. Credit for this success must be shared with his capable assistants in the preparation of plans, specifications and office work—

ASSISTANT ENGINEERS

Carroll W. Simon James W. Roland
Carroll R. Thompson Atwood L. Bliss
Edward P. Haines

ELECTRICAL AND MECHANICAL ENGINEER

Leonard Work

STRUCTURAL DESIGNER

Emil Kreuger

DRAFTSMEN

Benjamin L. Berry John R. Gorman
Arthur J. Drew

STRUCTURAL DRAFTSMEN

Walter S. Miller James F. McGarity

ARCHITECT

Harry Rasch

and in the supervision of the construction and work in the field—

ASSISTANT ENGINEERS

Edward T. Fullen John Gwilliam
John Downham

CHIEF WHARFINGER

Donald S. MacBride

In addition to preparing plans for the bulkheading incident to the widening of Delaware Avenue, and for the Schuylkill River improvement, this Division prepared plans for and superintended the construction of the following piers:

First: Municipal Pier No. 19, North Delaware Wharves, located at the foot of Vine Street, Delaware River. This pier is 571 feet long by 166 feet wide, with a gross area of 179,860 square feet. Its substructure consists of reinforced concrete cross walls on pile and timber foundation, which makes it a permanent structure, and was the first of that type to be built by the City. The superstructure is double deck, of reinforced concrete and steel, faced with copper on the outshore and inshore ends, thus making the entire structure fireproof. There are three towers on the pier—one on the outshore or river end, at a height of 112 feet above the steel level, and two on the inshore end, at a height of 10 feet above the street level. The pier is provided with Immigrant Quarters on the second deck, and is equipped with electrically operated freight elevators and cargo chutes. Two depressed railroad tracks with Belt Line connection, having a capacity for twenty-two cars, run through the center of the pier, giving the north and south sides independent rail service. This pier was constructed at a cost of \$683,658.40.

Second: Municipal Pier No. 16 South Delaware Wharves, located at the foot of Dock Street, Delaware River. This is a structure 120 feet wide by 582 feet long, with a gross area of 69,840 square feet. Its lower



PIER NO. 78 SOUTH DELAWARE WHARVES.
CONTRACT NO. 244; DATE OF COMPLETION
18 MONTHS FROM FEBRUARY 16, 1916;
DATE OF PHOTOGRAPH NOVEMBER 28, 1916;
AMOUNT OF WORK COMPLETED TO DATE
54.5 PER CENT. INNER END OF PIER, NORTH
SIDE, LOOKING SOUTH.

PIER NO. 78 SOUTH DELAWARE WHARVES;
CONTRACT NO. 244; DATE OF COMPLETION
18 MONTHS FROM FEBRUARY 16, 1916; DATE
OF PHOTOGRAPH DECEMBER 28, 1916;
AMOUNT OF WORK COMPLETED TO DATE
—SUBSTRUCTURE—60 PER CENT.



DEPARTMENT OF WHARVES, DOCKS AND FERRIES

PIERS 38 AND 40 SOUTH DELAWARE WHARVES. PERSPECTIVE VIEW LOOKING NORTH ON DELAWARE AVENUE. JANUARY 24, 1916.



DOCK STREET PIER NO. 16 SOUTH DELAWARE WHARVES. VIEW LOOKING SOUTH

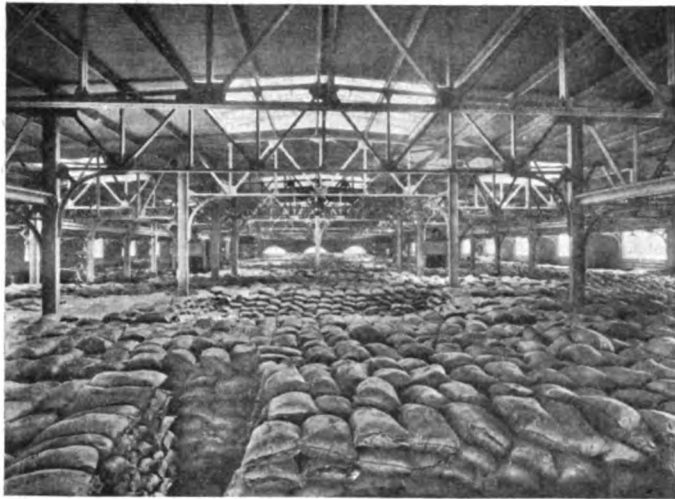
work is of the permanent timber, pile and concrete cross-wall type, topped off with a concrete slab floor, and surmounted by a one-story concrete and steel warehouse shed for the whole length of the pier, except at the inshore end where a two-story concrete office building is provided. Two sunken car tracks run down the center of the pier, with a capacity for twenty-two cars. The structure is electrically lighted inside and out, and is provided in addition to the regular fixed lights, with portable cargo lights for use inside of the ships tied up at the pier and railroad cars on it, and has an equipment of portable electric winches for use in supplementing the ship winches used for discharging cargo. This pier was constructed at a cost of \$321,912.89.

Third: Piers Nos. 38 and 40 South Delaware Wharves, located between Catherine and Christian Streets. They are each 180 feet wide by 550 feet long, two stories in height, with docks 200 feet or more wide flanking each pier, and on their inshore ends bulkhead sheds 30 feet in width extend laterally from the piers parallel with the marginal street, affording additional cargo-handling and storage space and platform room for unloading goods from drays and trucks onto the pier deck at grade. The substructures of the piers are of a permanent and substantial type being of piles and timber up to the low-water plane, and concrete above this. The pier sheds are constructed of steel and concrete, two stories in height on the piers themselves, and one story on the bulkhead. The piers are fireproof in character, and in order to make

impossible the spread of cargo fires, they are provided with the most up-to-date fire-extinguishing apparatus. The mechanical cargo-handling equipment of the piers is by far the best and most efficient in the Port, and, so far as is known, the best in the United States. Electrically operated elevators, of both the platform and continuously operating cargo types, as well as cargo chutes and hatches for transferring freight between the upper and lower decks, are liberally provided. In addition, each pier is equipped with a number of portable electric winches operated under a system of "remote control." The plans and specifications for these two piers were prepared, and the work of construction was done during the administration of former Directors George W. Norris



STEAMSHIP "CAROLYN," OF THE PHILADELPHIA-SOUTH AMERICAN STEAMSHIP CORPORATION; INAUGURATED THE SERVICE OF THE NEW LINE BY SAILING FROM MUNICIPAL PIER NO. 38 SOUTH, ON OCTOBER 17, 1916.



PIER NO. 40 SOUTH DELAWARE WHARVES.
CARGO OF 8,700 TONS OF RAW SUGAR ON UPPER DECK, MARCH
23, 1916.

and John Meigs at a cost of \$1,034,555.12. These piers, together with Piers Nos. 19 North and 16 South Delaware Wharves, which have been built since the organization of the Department of Wharves, Docks and Ferries, are among the most modern and best equipped piers along the Atlantic Coast.

Fourth: Pier No. 78 South Delaware Wharves, which is the first pier of the Moyamensing Group—consisting of ten large structures averaging 300 feet in width by more than 1000 feet in length, ranging in dimensions from 250 feet by 900 feet for the smallest of them, to 300 feet by 1200 feet for the largest—is located at the foot of McKean Street, and is in the course of construction. This pier will be 900 feet long by 250 feet wide, with 300 feet deck space on each side. The substructure will be of solid



PROPOSED COMMERCIAL PIER NO. 9 NORTH AT CHERRY STREET
DELAWARE RIVER

earth-filled type, and the superstructure of steel and concrete fire-proof construction, two stories high. It will be provided with the usual sunken double car track connections to the Belt Line Railroad, and in addition, with a depressed roadway for vehicles running lengthwise down the middle of the pier, to permit the loading of freight on to dray platforms on the same level as the pier floor.

Cargo handling machinery of an advanced type will be installed on it.

SCHUYLKILL RIVER BULKHEAD

The project for building a bulkhead along both banks of the Schuylkill River from its mouth to the head of navigation at Fairmount Dam, approximately seven miles, was commenced in 1915, and the work has been continued during the year 1916. When completed, the bulkhead will increase the value of this stream as an adjunct to the Harbor of Philadelphia 100 per cent., and will give an opportunity not only to reclaim the land between the improved channel and the high-water mark, but it will also protect the improved channel by making it less liable to silt up with deposits from the mud banks and save the City a considerable portion of the annual expense for dredging this stream.

HYDROGRAPHIC CORPS

The work of this Corps is under the immediate super-



PROPOSED COMMERCIAL PIER NO. 30 SOUTH AT KENILWORTH
STREET DELAWARE RIVER SOUTHWARK GROUP

vision of Civil Engineer-Dockmaster Cheston M. Bryant, who has, since the Department was created, superintended the removal of 1,029,083 cubic yards of material from the Delaware and Schuylkill Rivers under contract. Of this amount there was removed from docks along the Delaware River 643,250 cubic yards before the City Dredging Plant was purchased. The remainder of the work resulted in a 30-foot channel in the Schuylkill River from the mouth to Point Breeze at half-tide, and the maintenance of same; also a 30-foot channel M.L.W., 400 feet wide, in the Dela-



PROPOSED MOYAMENSING PIERS.
PERSPECTIVE VIEW FROM SHORE.

DEPARTMENT OF WHARVES, DOCKS AND FERRIES

ware River between Dyott Street and William Street. This portion of the channel was dredged first to 28 feet M.L.W., in the winter of 1910, and finally to 30 feet M.L.W. in the summer of 1916.

A 6-foot channel at M.L.W. was also dredged in Frankford Creek from its mouth to near Orthodox Street.

This Corps has also charge of all surveys made in the Department, including shore line, channel property surveys, and laying out of pier and bulkhead work, and has instituted and put in operation a system of Center Line Channel Ranges in the Schuylkill River, which has been of inestimable benefit to navigation in this stream.

The third division—that of the City Ice Boats and Dredges, has been under the direct supervision of Mr. James S. Jefferson, first as a Bureau of City Ice Boats, from June 1, 1900, to November 1, 1907; then as a Division of City Ice Boats, from November 1, 1907, until January 1, 1911; and as the Division of City Ice Boats and Dredges from that date until the present time.

CITY ICE BOATS

This Division has under its control three ice boats—City Ice Boat No. 1, which is an iron hull paddle wheel ice breaker, 172 feet long, built in 1866, at a cost of \$125,000.

City Ice Boat No. 2, also an iron hull ice breaker, 185 feet long, of the same type as City Ice Boat No. 2, built in 1868, at a cost of \$165,000.

City Ice Boat No. 3, or the *John Weaver*, a 232-foot long, 45-foot beam and 22-foot draft, 3600 H. P. steel ice breaker, built in 1905, at a cost of \$400,000.

This latter vessel is a duplicate of the Russian Ice Breaker *Ermack*, only smaller, with half the power, and at the time of its launching was the most improved vessel afloat so far as ice breaking was concerned.

These vessels are operated and maintained by the City

of Philadelphia in patrolling the Delaware River and Bay from Philadelphia to the sea during the ice season, in order to break the ice and allow a free passage for vessels going to and from the City. Without their assistance commerce to the Port of Philadelphia in severe winter months would be seriously retarded. The crew of the three boats, when in full commission, consists of about ninety men.

CITY DREDGING PLANT

In 1910 the City began to purchase the present dredging plant, securing one hydraulic dredge, the *Philadelphia*, 100 feet long, and one dipper dredge, the *Schuylkill*, 100 feet long; two tugs, the *Kensington*, 81 feet long, and the *Southwark*, 66 feet long; and seven scows. There has since been purchased one dipper dredge, the *Poquessing*, 70 feet long; one tug, the *Passyunk*, 86 feet long; and six scows. The total cost of the plant to date has been \$357,000, and it is used to dredge City-owned docks and docks into which City sewers empty; the channel of the Schuylkill River and portions of the Delaware River between the ends of piers and the established pierhead line, where such piers do not extend outstream as far as this imaginary line.

Since 1911, when the plant went into operation, there has been dredged a total of 2,990,671 cubic yards of material, at a cost of \$268,973, during which time the plant earned \$101,687—the portion of expense paid by the owners of docks where City sewers empty. During the period that the plant has been in operation, it has reclaimed 247.5 acres of land that were previously worthless, being below the level of tide water. This ground was filled in and raised to 5 feet above high water, making extremely valuable ground on the river front and improving the health of that particular locality by doing away with the marshes. Seventy-five and five-tenths acres were reclaimed at the House of Correction and are now used



PIERS 38 AND 40 SOUTH DELAWARE WHARVES
VIEW FROM RIVER LOOKING NORTH, MARCH 23, 1916.

for farming purposes; 114 acres were reclaimed at Girard Point; 52 acres at Mingo Creek, and 6 acres at Frankford Creek. The average yearly cost of operating the plant in round figures is \$50,000; the total receipts approximate \$20,000, and the number of men employed on the plant is about 54. During the winter season, the men employed on the Dredging Plant are transferred to the Ice Boats.

IMPROVEMENTS CONTEMPLATED

Realizing that a great Port is essential to a large manufacturing center like Philadelphia which must look for markets in other countries, the City has adopted a comprehensive plan for the further improvement of the port for the purpose of developing the general commerce of the country, and Councils have made provision for extensive improvements by appropriating to the Department \$13,300,000 for the purchase of property and for the erection of new piers and bulkheads, and has authorized the acquisition of property along the Delaware River front, south of Snyder Avenue, for the extension of the Moyamensing Group. Upon this land it is proposed to erect additional piers of the general type of Pier No. 78 South, at McKean Street. They will be from 900 to 1200 feet long and from 250 to 300 feet wide, having railroad

tracks laid upon their decks connecting with the Belt Line System around the City, thus giving opportunity for shipments from all lines of railroads entering the City.

Property is to be acquired at the foot of Kenilworth Street, and a double-deck pier, somewhat similar in design to the Southwark Group (Piers Nos. 38 and 40 South Delaware Wharves) will be erected thereon. This pier will be 550 feet long and 180 feet wide, and equipped with modern machinery for the quick and expeditious handling of cargoes. The work upon the pier will be commenced early in the spring of 1917.

The City has also arranged to acquire property on the Delaware River, at the foot of Cherry Street, and a contract has been let for the construction of a single-deck pier, 550 feet long and 100 feet wide, designed for local traffic, this location being most advantageous for that character of trade.

It is the purpose of the Department to continue the opening and improvement of Delaware Avenue northward from Fairmount Avenue, so as to ultimately develop a marginal, commercial avenue along the river front from the southern section of the City to its most northern boundary, thus giving facilities for reaching the wharves and docks not only by railroad tracks but also by trucks and teams.

OBITUARY

OTTO C. WOLF

OTTO C. WOLF, a widely known architect and construction engineer, a member of the Union League and Vice-president of the Northwestern National Bank, died at his home, 6471 Woodbine Avenue, on December 19, 1916.

Mr. Wolf had been a member of the Engineers' Club since 1886, and older members of the Club recall him as having been very active in the Club affairs in earlier days. He was born in Philadelphia, and after a public school education was graduated from the University of Pennsylvania, in 1876. It is notable that this class was the first class in engineering to be graduated from the University of Pennsylvania, and it has besides Mr. Wolf a number of very celebrated men. Among these were Dr. Hugo Rennard, Professor of modern languages at the U. of P.; Mr. Wm. Sellers and Mr. Wm. L. Saunders, President of the Ingersoll-Rand Co.

After leaving school, Mr. Wolf entered the machine shop of Morgan and Orr, learning the business from the ground up. Later, while still with this Company, he designed a completed number of special machines, among which were the coin-making machines adopted by the Japanese Government. Several years ago, Mr. Wolf, together with the members of the American Institute of Mining Engineers, visited Japan, and was gratified to see

in use the same machines that he had designed and completed many years previous. These machines are still doing service to-day.

He interested himself in refrigerating machinery, and saw the development of this kind of machinery from its earlier stages until the present time. It was not long before he became an authority on the subject of cold storage, and designed many complete plants of this kind. The City of Chicago was the field of much of the earlier development of storage goods, and Mr. Wolf, together with his cousin, Mr. Fred Wolf, was instrumental in starting a number of cold storage plants now running in that city. One of his largest designs was the plant of the Chesapeake Dry Dock and Construction Co. at Newport News, this entire plant covering many acres, and was built upon what was formerly a barren and waste swamp. The designing of this plant not only included the plant complete, but embodied the laying out of the town and even the designing of its principal office building and banks.

He was a member of the American Institute of Architects and Engineers' Club; The American Institute of Mining Engineers; the American Society of Mechanical Engineers; the American Society for Testing Materials and the Masonic Order. He was 60 years old.

Economics of Power Plants*

By FRANCIS R. WELLER

CONSULTING ENGINEER

MR. PRESIDENT AND GENTLEMEN OF THE ENGINEERS' CLUB OF PHILADELPHIA: Before starting to read my paper I would be very unappreciative indeed if I did not voice my deep feeling of appreciation for the honor that you gentlemen have bestowed upon me this evening in inviting me to come over from Washington to address you. The City of Brotherly Love I know is



FRANCIS R. WELLER
Consulting Engineer

prominent in a great many things, and I think not among the least of its claims to greatness is the fact that you have here the largest local Engineering Society in the country, if not in the world. In Washington we have likewise a similar Society, made up of members of the various local branches of the National Societies, and the organization has worked very successfully, as I believe it has here. I bring you this evening the heartiest greetings of your younger and smaller brother, with the invitation and hope that whenever you happen to be in Washington on either the second or fourth Tuesdays of the month—except in the proverbial hot months of July and August—you will honor us with your attendance. The meetings are then held at the Cosmos Club, and I am sure we will be very glad indeed to have you all with us and to show you that we are trying to do things down there in the way of coöperation among engineering lines of getting better acquainted to promote the good fellowship and feeling among all engineers—something which I think is very worthy of promoting—and I would be very glad indeed to meet you all in Washington.

* Meeting December 19, 1916.

The growth of the electrical industry in the past twenty-five years has been one of the most remarkable achievements that the modern industrial world has ever witnessed.

The commanding position which electricity occupies in our commercial and domestic life will certainly lead to greater extension of all its present uses, and to its application in new fields.

The following figures taken from the *Electrical World* will give some idea of the importance of electrical industries of the United States:

	Investments or capitalization	Persons Employed	Annual Earnings or Sales
Central electric stations	\$3,038,000,000	104,000	\$403,300,000
Isolated electric stations	1,519,300,000	52,000	201,600,000
Street and electric rail- ways—power generation, distribution and applica- tion	2,681,800,000	165,000	350,500,000
Street and electric rail- ways—railways operation	2,681,800,000	165,000	350,500,000
Electrified divisions of steam railroads	204,700,000	15,000	30,300,000
Telephone	1,262,760,000	237,000	329,900,000
Telegraph (land and ocean)	231,600,000	44,000	75,300,000
Electric machinery, appa- ratus and supplies (in- cluding electric products of other industries)....	469,100,000	185,000	383,300,000
Electrical dealers and con- tractors	15,000,000	50,000	120,000,000
Electrical jobbers	25,000,000	6,000	80,000,000
	\$12,129,660,000	1,023,000	\$2,324,700,000

In general, most of the estimates are based upon returns of the United States Bureau of the Census. A comparison of the estimates in different sections of the industry on isolated electric stations made it apparently reasonable to assume that the totals for this branch are one-half of those for central stations.

Statistics for the electrified mileage of steam railroads are based upon the latest available figures of miles of track to which were applied the approximate averages of electric and steam railroad statistics. The very costly terminals were not taken into account.

We can see from the above data what an important part electricity plays in our modern civilization; especially in the field of manufacturing and industrial arts. Electric power has caused revolutionary changes, making it possible to carry on industrial operations on a scale not even dreamt of a few decades ago.

At the present time the greater portion of the civilized

world is engaged upon a war of destruction, and its effects are felt everywhere. Radical changes and adjustments must inevitably follow the coming of peace, which will undoubtedly inaugurate the keenest competition among all nations for industrial trade; especially will those nations now at war endeavor to recoup at least some of their enormous losses by expanding their commerce. Already the lines are being drawn, and we have witnessed in the past few months the economic union of the Entente powers for the purpose of expanding their commerce after the war is ended, to the exclusion of the enemy powers, and possibly, also, the neutral nations. An economic union has also been formed by the Central powers; so it is evident that if the commerce of our country shall continue to increase, we must necessarily be prepared when the war ceases to meet the keen competition of the warring nations in the fight for trade. It is evident, therefore, that all our resources should be developed and utilized along the most economical lines. A thoroughly industrial preparedness will not only enable us to maintain our present commanding position, but also, in the event of war, every manufacturing plant within the boundaries of this country will be called upon to do its part by the national service.

The necessity of preparedness was strikingly expressed by Professor Whitehead, in a recent address before a British Association: "If we wait for the necessity of action before we begin to arrange our ideas, in peace we shall have lost our trade, and in war we shall have lost the battle."

Mr. Howard E. Coffin, member of the Naval Consulting Board, in an article entitled "Electrical Industry at the Foundation of Defense," says, "There is no more important link in the chain of industrial machinery entering into the national defense than the great central stations upon which manufacturing companies are dependent for power, and the uninterrupted operation of these sources of industrial energy must be assured at all hazards in war as well as in times of peace."

Since electric power plays such a wide part in all industrial and manufacturing activities in this country it is proper that every effort be made to investigate the most economical methods of power generation, distribution and utilization. It shall be the purpose therefore of this paper to outline some of the economic principles which should be considered in the generation and distribution of electrical power.

Disregarding electric power generated by internal combustion engines, we have two great classes of electrical generating plants: Steam-electric and Hydro-electric power plants.

Perhaps in no other class of public utilities have the percentages of failures been so great as in the development of hydro-electric plants. Nearly all of the large water power plants now in operation have gone through a period of financial embarrassment, if they have not at some period become absolutely bankrupt. It would be of interest, therefore, to point out some of the causes of

such failures, and to show in what fields hydro-electric plants are best utilized.

It can be clearly demonstrated that except within narrow limits, the field for the use of power derived from steam-electric power plants and from hydro-electric power plants widely differs.

The development of the modern steam-electric power plant has made rapid strides in the last ten years, due to the increasing size and efficiency of the modern steam turbine. Units of 50,000 kilowatts are now projected, if not actually under construction; also, steam boilers have rapidly increased in size, and further reduction in the cost of steam power also has been accomplished by the increase in steam pressures, high superheat, improvement in the design of condensers, stokers and other apparatus, so that to-day there are in operation and being built, several steam-electric plants of capacities of 200,000 kilowatts or more. Such plants under normal business conditions can be built for \$60 a kilowatt, or about one-third the unit cost of the average hydro-electric plant, and where such plants are built near the coal mines, power can be developed, including fixed charges, in many cases under one-half cent per kilowatt hour. East of the Mississippi River where fuel is comparatively cheap, the great reduction in the cost of steam-electric power has rendered many water powers unworthy of development which but a few years ago would have been considered attractive investments; because such water powers cannot meet the critical test of being able to develop electrical power cheaper than a steam-electric plant of equal capacity to supply the same market.

It would seem to be a waste of our natural resources to continue the consumption of coal at ever-increasing rates, while millions of horse-power of water powers are still undeveloped; although necessarily a large portion of this undeveloped power is not susceptible of economical development at the present time, nevertheless an enormous amount of such water power can be economically utilized in certain fields. It should be the duty of all engineers who are true conservationists to encourage the development of such water power, and to educate the public up to their underlying economic principles, so that the cloud, which has been spread over water power developments by ill-advised investments in unsound projects, will be raised.

In the past, hydro-electric plants with but few exceptions have been operated for the principal purpose of supplying power for various manufacturing industries, lighting cities and towns, operation of street railways, and in some cases, trunk line railroads which have been electrified. These hydro-electric plants, as a rule, are located at some distance from the places where the generated power is consumed, involving the additional cost of transmission line systems, with the added chances of interruption to service; whereas, the steam-electric power plant is not limited to a definite location, but it can be built near the centre of gravity of the load.

It is evident that the cost of operation of a hydro-

electric plant is irrespective of the load factor of such a plant. Practically all items of expense, such as bond interest, depreciation, taxes and insurance, administration and operating expenses, are fixed amounts. On the other hand, the available power which is derived from the flow of the stream fluctuates within wide limits, so that the amount of available power which can be sold likewise varies within wide limits. In order to assure the user of power of continuous service, only the power developed from the minimum flow of a stream can be sold, so that for the greater portion of the year, large amounts of unused power are constantly running to waste. It would be quite possible to install additional generating capacity at every power plant over and above that actually installed to deliver primary power at a unit cost considerably less than the unit cost of the primary power development, but as a rule, there is very little market for such so-called secondary power, and it would require the investment on the part of the power user in a steam reserve plant to generate his power requirement whenever the hydro-electric plant is unable to deliver the same. This additional investment oftentimes makes it unprofitable for the power user to purchase such secondary power.

A large number of hydro-electric companies have found it necessary in order to insure continuous power service to their customers, to build auxiliary steam-electric plants to supplement their hydro-electric plants. For example: the Southern Power Company has now in service four steam-electric plants of a total capacity of 32,000 kilowatts, operating in connection with hydro-electric plants of total capacity of 118,000 H.P. This Company's transmission lines include 1520 miles of high tension circuits and cover a large portion of North and South Carolina, supplying over 150 cotton mills and a territory embracing a population exceeding 950,000, with electric power. The steam-electric plants have been built at most feasible locations with respect to their power load.

The Baltimore Consolidated Gas & Electric Co. obtaining hydro-electric power from the McCall's Falls Ferry hydro-electric plant on the Susquehanna River, finds it necessary in order to insure continuous service to its customers in Baltimore, to maintain its large steam-electric plant in Baltimore under steam and always ready to pick up the load, and at the same time, has a storage battery plant representing an investment of one million dollars, constantly floating on the line. This Company is now making large additions to its steam-electric plant in order to maintain an adequate reserve, and I am reliably informed that this steam-electric plant could generate power cheaper than the cost of hydro-electric power now being delivered at Baltimore. One reason for this is undoubtedly due to the fact that since this contract was made a few years ago, the cost of producing steam-electric power has been so reduced that the advantages which hydro-electric power once had as to low cost have now been lost.

A few miles above Washington, on the Potomac River

at Great Falls, there is an undeveloped water power capable of maximum development of 100,000 H.P., but at times of low water the total available power based on 40 per cent. load factor would not be in excess of 20,000 H.P. Since the days of George Washington various projects have been advanced for the development of this water power. A few years ago some government officials conceived the idea of developing this power for the purpose of lighting the government buildings and the streets in Washington, and also for furnishing power for the various government requirements in the Capital City. An appropriation was made by Congress for preliminary surveys, and preparation of plans and specifications. These were completed about three years ago, and since that time efforts have been made on the part of various government officials to secure from Congress the necessary appropriation for the construction of this plant.

I have had occasion to make a careful study of this proposition, and it can be proven beyond a question that a steam-electric plant of equal capacity could be built in the city of Washington, which would be capable of generating and delivering power for all government and municipal requirements, at a cost considerably below the cost of power from the proposed hydro-electric plant. In order to insure continuous supply of 100,000 H.P. it is proposed to build a steam auxiliary plant of total capacity of 66,000 H.P. and adding this investment to the cost of hydro-electric plant, it is found that the actual cost of power delivered from this proposed plant, based on maximum of 100,000 H.P. development, and on 50 per cent. load factor, would amount to 1.89 cents per kilowatt hour.

A vast majority of citizens of Washington are strongly in favor of this project, believing, as they do, that if this hydro-electric plant is developed, they would be able to purchase current for lighting their homes at three cents per kilowatt hour, whereas they are now paying ten cents per kilowatt hour for this current.

It is probable that this development will be built within the next few years in spite of the fact that it is unsound economically, and will impose a heavy burden of taxation on the citizens of Washington, as well as high annual cost on the United States Government.

It is certainly the duty of the engineering profession to enlighten the general public upon economic principles of power development, as well as upon other engineering subjects so as to avoid such expensive mistakes.

Many cities and towns have fallen under the delusion that by the development of water power, manufacturing industries would be attracted to such places, and in consequence such a water power would be a great stimulus for the growth of the city. As an illustration of this statement, six years ago the citizens of one of the small cities in the South conceived the idea of developing a water power, believing that by so doing their city would become an important manufacturing centre. Bonds were voted before a thorough investigation of the project had been made, and then I was retained by the City as engineer to

take charge of the work. After the surveys had been completed, and cost of the project determined, it was quite apparent that the construction cost would be excessive, and that a sufficient power market did not exist, therefore, at a special meeting of the City Council, I presented my report and showed that instead of developing this water power and transmitting same a distance of twenty-two miles to the city, a steam-electric power plant costing less than one-third of the cost of the water power development could be built right in the city, and the power could there be generated at a cost considerably less than the cost of the delivered water power. I therefore strongly recommended that the water power project be abandoned. Much to my surprise the Council politely but firmly informed me that bonds had been voted to build a water power, and that water power development should be built, and if this project could be built within the allotted bond issue, I was instructed to go ahead and build it; which was done. I might state that while the plant physically has been entirely satisfactory, it has never been a financial success. The revenue derived from the sale of power has not been able to meet the operating expenses and fixed charges, and the industries that were expected to come to the city have never arrived.

While the cost of steam power has been reduced and will undoubtedly be further reduced, due largely to increase in efficiency in the conversion of heat into power, it must be remembered that to-day only 17 per cent. of the energy in a pound of coal is utilized, and while this efficiency is so low as to render further increases not only possible but probable, the efficiency of water power, except for a slight improvement in the efficiency of large water turbine units, has reached its maximum and further reduction in the cost of water power cannot be expected. The unit cost of building steam-electric plants has likewise been reduced, whereas the cost of hydro-electric plants, in the construction of which labor represents the largest item of cost, has been greatly increased. Except in large hydro-electric plants operating under ideal conditions, and there are practically none in the eastern half of the United States except at Niagara, I do not believe there are any hydro-electric plants now in operation which can more satisfactorily meet the demands for diversified power service than large steam-electric plants where coal can be purchased at a cost not exceeding \$4.00 per ton. In making this statement, I have in mind not only the actual cost of delivering power from each class of plant, but also, the question of reliability of service.

Let us consider the comparative cost of power between a typical modern steam-electric power plant and hydro-electric plant; each having an installed capacity of 50,000 kilowatts, and each designed to serve as a central station, supplying general lighting and power service. Such a plant would operate on about a 40 per cent. load factor, the total yearly output being 175,000,000 kilowatt hours. A modern steam-electric plant of this magnitude can generate one kilowatt hour with one and one-half pounds of coal.

If you except Niagara and the St. Lawrence River and some of the high head water powers in the western states where it is possible to regulate the annual stream flow by means of large storage reservoirs, there is no river in the United States the potential value of which as a water power producer is not affected by an occasional period of very low water.

Since continuous power service is essential in the case under consideration, it would, therefore, become necessary to provide some steam auxiliary power. It is impossible to establish a general rule for determining the size of necessary steam auxiliary plant as conditions widely vary in each particular case, but for the sake of a fair comparison it will be conservative to assume a steam auxiliary plant having a capacity 20 per cent. of that of a hydro-electric plant, or installed capacity of 10,000 kilowatts. In making this comparative estimate of operating cost, I will assume the conditions most favorable to hydro-electric plants, i.e., the steam auxiliary plant will not be operated during the year. It is obvious that if it becomes necessary during high or low water to operate this steam auxiliary plant, the cost of operating the same must be added.

We will allow 12 per cent. charges to cover insurance and amortization and taxes in each case.

Total cost of steam-electric plant, 50,000 kilowatts at \$60.00 per kilowatt	\$3,000,000
Total cost of hydro-electric plant, 50,000 kilowatts at \$160.00 per kilowatt	8,000,000
Total cost of steam-electric auxiliary plant, 10,000 kilowatts at \$60.00 per kilowatt	600,000
Total cost of hydro-electric plant with auxiliary	9,600,000

COMPARATIVE ANNUAL OPERATING STATEMENT.

	Hydro-Electric Plant	Steam Electric Plant
Fixed charges at 12 per cent.	\$1,052,000	\$360,000
Insurance	12,000	20,000
Ordinary operating expenses except coal	55,000	80,000
Administration	20,000	20,000
Coal, 132,000 tons @ \$3.50 .....	.....	462,000
Total annual cost	\$1,139,000	\$942,000
Cost per K.W. hour, 4 per cent. load factor	0.65 cents	0.54 cents

Even though we deduct the fixed charges on the steam auxiliary plant of \$72,000, which has been added to the annual cost of the hydro-electric plant, there would still be a saving of \$125,000 per annum in favor of the steam-electric plant. The relative saving in cost in favor of the steam-electric plant increases as the price of the coal decreases.

Using the same operating cost as above given, the following table shows the cost of producing power per kilowatt hour by a 50,000 K.W. steam-electric plant with coal at various prices per ton. Also, table shows the limit in cost of hydro-electric plant per kilowatt of installed capacity that will be capable of producing power at the same cost per kilowatt with various costs per ton for coal.

ECONOMICS OF POWER PLANTS

TABLE SHOWING COST PER KILOWATT OF STEAM-ELECTRIC POWER
WITH VARIOUS FUEL COSTS, IN A PLANT OF
50,000 K.W. CAPACITY.

Coal cost per ton in dollars	\$1.00	\$2.00	\$2.50	\$3.00	\$3.50	\$4.00
Cost K.W. steam-electric plant in mills	3.47	4.23	4.38	5.00	5.41	5.80
Limiting cost per kilowatt installed, hydro-electric plant	88.50	109.50	120.50	131.50	142.50	153.50

From this table we see that only where the cost of coal is high can hydro-electric power successfully compete with steam power produced by large power plants. Of course, as I have previously stated, there have been hydro-electric plants built under the unit cost of \$160 per kilowatt of installed capacity where hydraulic conditions were most favorable, but this cost of \$160 per kilowatt is a conservative figure, when the average cost of large hydro-electric plants that have been built in this country is considered.

Hydro-electric power is particularly well adapted for supplying power to manufacturing plants operating on a high load factor, such as the various electro-chemical works, electro-metallurgical works and nitrogen fixation plants. When one considers that except in rare instances does the central station power plant operate at a greater yearly load factor than 50 per cent. it is apparent that where hydro-electric power is used continuously throughout the twenty-four hours, so that the load factor will approach 100 per cent., the cost of producing power, assuming that no storage is available, would be just one-half the cost per kilowatt of power sold when the plant is operating on 50 per cent. load factor; or if it is feasible to hold back sufficient of the stream flow so that the plant can be operated on 50 per cent. load factor, the plant capacity must be necessarily twice as large as a plant operating on the basis of 100 per cent. load factor, since the total daily output is the same in each case.

The electro-chemical industry is but of recent growth, but already this industry has assumed vast proportions. Such industries have a fundamental interest in the development of cheap power and naturally Niagara has been the centre of this class of industrial development. Niagara power is no longer cheap. The present rate of three-tenths of a cent per kilowatt hour, \$20 a year, is, as I have already shown, about equal to the cost of developing power by means of large turbo alternators in steam-electric plants located near the coal fields, so it is necessary to look elsewhere for cheap power.

In the Southern Appalachian Mountains there are at the present time approximately two and one-half millions undeveloped primary horse-power. If auxiliary power were provided to supply short seasons of water deficiency, and if the storage facilities of these streams were developed, the total available water power would be increased at least fivefold. While, of course, cheap power is not entirely the controlling factor in electro-chemical industries, the question of transportation and raw materials likewise plays an important part, nevertheless, it is

feasible, by means of transmission lines, to locate the manufacturing plants at some convenient industrial or transportation centre where the raw materials can be economically assembled.

Since cheap hydro-electric power is essential for successful application to the various electro-chemical processes, a large portion of the undeveloped water power of the United States at the present time is not available for this use. There is, however, sufficient of such power capable of economical development to meet all the present demand for additional power, and to make us practically independent of foreign products and raw materials which are required in connection with these various processes.

Let us briefly consider a few of the many uses to which hydro-electric power can be applied.

First of all, water power has a close relationship to the problem of national defense. The United States has no adequate domestic source of fixed nitrogen. Nitric acid is an absolute essential element in the manufacture of all forms of explosives, and we are dependent upon the supply of Chilean nitre, and in times of war this supply might easily be shut off.

There are several successful processes for the fixation of atmospheric nitrogen. The electric arc process, the cyanamid process using electric power for making calcium carbide which is later employed for combining the nitrogen of the air, and others. This problem of the production of nitrates or ammonia for National defense is also intimately associated with the problem of production of cheap fertilizers, and also for the development of the aniline and chemical dye industry, concerning which so much has been written since the outbreak of the European war, due to the interruption of the German supply of dyestuffs. No simple chemical is so generally important to this industry as nitric acid. Certainly a consideration of our present imperative needs for nitric acid, first in connection with our National defense; second, as an important element in the production of cheap fertilizer, without which this country can not successfully maintain its ever-growing population; and third, as an important factor in the development of our dye industry, should certainly stimulate engineers, as well as the officials of our National Government, to determine the most advisable steps to take to provide for our national needs for fixed nitrogen; and in connection with this question we should investigate and study the possibility, as well as limitations of hydro-electric power, because no industry unless it is built on sound economic foundation can survive.

Dr. W. R. Whitney in a paper entitled "Water Power and Defense," read before the American Institute of Electrical Engineers, and speaking upon the subject of nitrate production, states:

"It may be worth while to offer an opinion on a few of the questions naturally asked by the engineers concerning the possibilities of nitrate production in the United States in times of peace, and with present synthetic processes, commercial success is not possible if the electric

power costs are as high as \$15 per kilowatt year, and there are no profitable by-products. At about one-half this rate one or more of the present processes might possibly compete with the natural ante-bellum prices. This could not be done by the use of small isolated plants, nor less than full daily load of power. In other words, it would not attract those who ordinarily sell electric power."

The last Congress of the United States had authorized an appropriation of Twenty Million Dollars for the purpose of developing water power to operate a nitrogen fixation plant. If such plants are constructed by private enterprises as commercial investments, they might be considered also as important elements in our plan for an adequate National defense, and, therefore, such nitrogen fixation plants would be properly entitled to some governmental subsidy. In times of peace they could be utilized for the production of commercial fertilizers, or for the manufacture of dyestuffs, but in war times, the Government would take over their plants for the purpose of making explosives. By the Government carrying a certain portion of the overhead charges by means of a subsidy, it would be possible to generate electrical power at a cost low enough to manufacture fertilizers and dyes on a commercial basis.

It has been proposed by some students of National defense that the Government build a number of nitrogen fixation plants, and lease these plants to private corporations during times of peace. If we are to be independent of foreign sources of supply of our nitre, certainly some form of Government assistance is not only advisable but necessary.

Hydro-electric power has also been intimately employed in electro-metallurgical processes and notably in the production of aluminum, which metal is now refined entirely by means of the electric furnace.

At the present time the Aluminum Company of America is making an initial development of 80,000 H.P. for the purpose of supplying power to its Aluminum Reduction Plant at Maryville, Tenn. Their plans contemplate the ultimate development of 300,000 H.P. These hydro-electric plants will be located on Little Tennessee River about forty-five miles from Maryville. The same company has now under construction another hydro-electric plant and aluminum reduction works located at Badin, N. C., on the Yadkin River, where 75,000 H.P. is under development; the ultimate development being 100,000 H.P. At both places considerable secondary power will be developed, as it has been found profitable to utilize such secondary power in the production of aluminum, and at times of low water or extreme high water, to shut down a number of electric furnaces rather than merely to utilize the primary power of these streams. If such power was developed for the purpose of supplying the general power market, it would be necessary to build large steam-auxiliary plants in order to guarantee continuous service. These plants would add a heavy additional fixed charge against the cost of hydro-electric power. In addition to

the cost of auxiliary steam-electric plants, in order to reach the various power consumers, an elaborate and costly distribution system must be provided, whereas, when the power is used for electro-metallurgical purposes, the power is delivered to one substation in bulk, and the cost of retail distribution is eliminated.

The invention of the electric furnace revolutionized the process of aluminum reduction so that its cheapened cost has now brought this metal into widespread use.

The electric furnace is now being used in the production of the high grades of steel, and all present indications point to a much greater application of this method of steel production when the final perfecting of the electric furnace has been accomplished.

Hydro-electric power is also destined to play an important part in the production of bleach for our textile mills which can be commercially produced by the electrolysis of common salt. The by-product of this electrolysis, caustic soda, will produce from coal tar productions phenol which is a necessity in the manufacture of dyes, explosives and various other products, and at the same time, will produce our soaps and form a basis for the production of oxalic acid.

The above are only a few of the various applications of hydro-electric power in the fields of electro-chemistry and electro-metallurgy, but they indicate the almost boundless opportunity for the development of hydro-electric power which will ultimately be the key which will unlock from nature's storehouse the finished products necessary to the peaceful growth of industry, and at the same time will provide the means for the production of explosives, so essential for the nation's defense.

At the present time this vast supply of undeveloped power is practically locked up by adverse national legislation. The people of this country have been led to believe that hydro-electric power is essentially cheap power since there is no fuel required for its production. This idea has been emphasized by a small group of so-called conservationists whose influence on Congress so far has prevented the passage of reasonable power Acts that would permit private enterprise developing and utilizing this power now going to waste.

In order to disabuse the minds of the public, to enlighten Congress, and also to emphasize a few of the principles which should govern the passage of reasonable water power laws, the American Institute of Electrical Engineers, through its Board of Directors, has prepared a Declaration of Principles relating to the subject. We, also, as engineers, should feel it our duty to the general public to assist in this educational campaign by taking a more active part in public affairs so as to crystallize public opinion and to secure beneficent and constructive water power legislation.

I desire to quote several paragraphs from the Declaration of Principles by the American Institute of Electrical Engineers which so well expressed this question of the use of water power.

"WE AFFIRM that the real interest of the general public and the nation lies in the widest possible development and utilization of water power when and wherever such development can be made under conditions that will insure a cheap, reliable and permanent supply, when done under such regulations as will prevent oppressive monopoly, at the same time safeguarding and attracting the necessary investing capital.

"WE AFFIRM that of the many millions of undeveloped water power in the streams of the nation, a large proportion lies so remote from market or is so unavailable for use at or near their site, or involves so great construction cost, that many decades must elapse before such power can be profitably used for any purpose now apparent.

"WE AFFIRM that many more millions of undeveloped water horse-power in the stream of the nation are so situated in respect to competition with fuel generated power that their utilization depends on their value as cheap power sources for the so-called electro-chemical or similar group of industries involving their local use, requiring cheap and permanent power in large units, and only established where both cheapness and permanency prevail.

"WE AFFIRM that the general understanding that all water power is cheap power is wholly erroneous. Marked advances in efficiencies of steam turbines, boilers and accessories in the past decade and marked reduction in cost of such apparatus have resulted in radical reductions in operating costs of steam-electric power, and in many favorable cases proving such power cheaper than water power, developed under normal conditions. It is important to note that such steam-electric plants costing from one-quarter to one-third of the cost of a hydro-electric plant of equal generating and earning capacity can be established in any state in the Union where coal exists or can be cheaply transported, without onerous restrictions or conditions of any kind, and there exists a marked tendency to so establish them to the total disregard of water power as is shown by the many important steam-electric installations which have been built in this country in the past five years."

Let us now briefly consider some of the economic factors which govern present steam-electric power plant practice and which indicate the direction of its probable future development.

I have already briefly mentioned the rapid increase in the size of steam power plants in recent years, principally due to development of the steam turbine, so that now steam power plants of 200,000 kilowatts capacity and over are in existence at the present time.

The cost of producing power from steam plants is determined not only by the cost of fuel and the size of the plant, but also is determined by the load factor. As in the case of hydro-electric plants, the greater the load factor, the cheaper the cost of power, so it is the aim of all central station managers to build up a diversified power

market in such a way as to obtain the highest possible load factor. This is so necessary that the rates offered by central station companies to power consumers operating their plants on a high load factor, such for example as electro-metallurgical works, are in many instances remarkably low. One company is now selling power to a copper smelting furnace operating twenty-four hours a day with 4000 kilowatt demand, at the rate of five mills per kilowatt hour. Another large company has recently offered a rate of four mills per kilowatt hour to a steel company which will use electric furnaces having a maximum demand of 20,000 kilowatts, provided the guaranteed load factor shall not be less than 90 per cent. Such rates enable the steam-electric central station to fill up the low points in the daily load curves and by operating its station apparatus more nearly at its rated capacity, derive thereby a much more economical operating cost, and an increased income per kilowatt of installed capacity.

During the past few years a new idea has been applied to the operation of steam-electric power plants, and in my judgment, will eventually prove to be a revolutionary factor in the future development of electric power company's practice.

We have seen a tendency on the part of large central station companies to spread out their lines and feeders, so as to supply power to numerous smaller central station companies at a cost less than the actual cost of operating the individual power plants in these cities and towns. This tendency is based on sound economic principles.

The next step, which is but the evolution of this principle, is the construction of large power plants located at the source of the fuel supply. The Lehigh Coal & Navigation Co. has built at Hauto, Pa., a steam-electric plant for the purpose of utilizing the waste culm derived from the mining of hard coal. This Company has constructed an extensive system of transmission lines from its plants, and is now supplying power to a number of cities and towns, cement and other manufacturing plants in this section of Pennsylvania at a considerable saving in power costs to these various users.

The American Gas & Electric Co. is now building near Wheeling, W. Va., a 200,000 kilowatt steam-electric plant located near a coal mine, the output of which they have purchased. When this plant is completed, it will supply power to a number of central stations in cities and towns in Ohio, Eastern Indiana and West Virginia that are under the control of this company, and will supplant the individual power plants in these cities and towns.

The writer has recently designed and built in West Virginia a 10,000 kilowatt plant which is now about to be enlarged, located in the centre of the Logan County coal fields, and this plant is now supplying nearly all of the coal operations in this territory which previously operated their own individual plants.

It seems startling, but nevertheless a fact, that power can be generated and sold at a profit by power companies

to coal companies, at a saving to these companies compared with the actual cost of generating their own power.

The Virginian Power Company is operating a 40,000 kilowatt steam plant in West Virginia, and is likewise supplying power to a large number of coal mines in the New River coal field. Many other instances of this tendency towards the construction of large plants near the source of fuel supply can be mentioned, and they all point to the day when a large portion of the coal now transmitted over hundreds of miles of railroad, and consumed in power plants located at a distance from coal fields, will be converted into electrical energy at the mouth of coal mines, for the reason that it is more economical to transmit energy electrically by means of high tension transmission lines within certain limitations of distance.

The next step in the development of cheap electric power will be the tying together of such vast transmission line systems in order to maintain continuous service, and also by interchange of power between the various companies, it will be possible to improve the load factor of the various central stations, and thereby reduce the cost of power generation even lower than the cost of power now being generated in the largest and most modern of steam-electric power plants. It seems entirely logical to look forward to the day when this network of transmission lines will cover the country in a manner similar to the network of railroads in our vast system of transportation. Both transportation and power are equally essential for our industrial development, and for our national defense, and as the railroad trunk line systems gradually absorbed the smaller independent lines and branch line feeders, so, likewise, it is reasonable to expect that large steam power generation and transmission companies will absorb or consolidate the smaller power companies. Such companies will essentially be wholesalers of electric power and the distribution of power in certain territories will naturally remain the function of the existing central sta-

tion companies. The greatest element of uncertainty, the cost of generating power, however, will be eliminated, and the central station industry will be established on a much firmer basis.

To illustrate this tendency, I might mention that the transmission system of the Southern Power Co. is now connected to the transmission system of the Georgia Railway & Electric Co., which in turn is connected with the transmission system of the Alabama Power Co. The Southern Power Co. on the eastern limits of its territory connects up with the transmission system of the Carolina Light & Power Co. The lines of the Georgia Railway & Electric Co. are connected to the lines of the Tennessee Power Co., so that the entire high tension transmission line system in the industrial heart of the south, extending from the southern boundary of Virginia to the southern portion of Alabama, is interconnected.

The great value of tying together such transmission line systems was forcibly illustrated last summer when unprecedented floods in North Carolina temporarily caused the shutting down of several of the large hydro-electric plants of the Southern Power Company. This company called on both the Georgia Railway & Electric Co. and Carolina Light & Power Co. for power, and, thereby was enabled to maintain power service to the many cities and textile mills depending upon this company for their power.

If the growth of electric power companies shall be uninterrupted, it is the duty of every engineer interested in this industry, and there are very few engineers who are not either directly or indirectly affected, to endeavor to correct the mistaken judgments and ideas of National, State and Municipal authorities, as well as the general public, concerning the conditions which affect this all-important industry, and to emphasize and explain the economic factors which should be the basis for all power legislation.

Positions Vacant

Those in need of competent and experienced men will find it to their advantage to make their wants known through these columns. The Secretary of the Engineers' Club is constantly in touch with men capable of filling positions in all branches of Engineering. No charge is made for this service.

Engineer skilled in handling of materials, having had experience with conveying machinery and other mechanical means of handling and transporting materials, to study the handling of materials at plants of large industrial corporation. Apply Engineers' Club, No. 128—A.

Heating and ventilating engineer to study heating and ventilation and various similar problems at plants of large industrial corporation. Apply Engineers' Club, No. 129—A.

Combustion engineer to study combustion and boiler efficiency at plants burning bituminous and anthracite coal, plants ranging in size from 200 to 75,000 h.p. Apply Engineers' Club, No. 130—A.

Mechanical engineer who has had several years' mechanical experience, preferably in chemical industries, to investigate mechanical problems arising in the operations of a large industrial concern. Apply Engineers' Club, No. 131—A.



Technology Club of Philadelphia

D. K. BULLENS, Chairman

C. J. WALTON, Secretary
1421 Arch Street



THE January Meeting of the Technology Club was held Wednesday evening, January 3rd, at the Engineers' Club. The address of the evening was given by C. Leon Cowles, Bacteriologist, of the H. K. Mulford Company, Glenolden, Pa.

THE CAUSE, PREVENTION AND CURE OF DISEASE BY BACTERIA

BY C. LEON COWLES

The science of bacteriology dates from the 17th Century when the optician Leewenhoek, with his improved microscope, first saw the minute living particles called "germs" or "bacteria."

The bacteria are living plants in the form of extremely small rods or spheres, approximately $1/25,000$ " in length or diameter. They multiply with great rapidity, doubling in number every twenty minutes, by the simple process of merely breaking in two.

These minute forms of life are found everywhere,—in air, water, food, in dust and upon clothing. Only a few types cause disease, and they do this, not by their mechanical irritation, but by the poisonous substances formed during growth in the human body.

The simplest case of the cure of a disease through the agency of the bacteria that cause it is the use of diphtheria antitoxin. In the manufacture of this product living diphtheria bacilli are grown in an incubator in meat broth. After seven days the bacteria are filtered out of the meat broth and the filtrate is found to contain the chemical poison which actually causes diphtheria. This poison is then injected into the blood of horses. The horses, which actually have a mild case of diphtheria, produce in their blood the antidote for this poison. If the blood is then drawn from the horse it will contain diphtheria antitoxin, which is nothing but the antidote for the poison produced when diphtheria "germs" grow in the human throat or anywhere else. The liquid portion of this blood, separated from the red corpuscles, constitutes the antitoxin.

The tetanus or "lockjaw" antitoxin is made in exactly the same manner as the diphtheria antitoxin. These two antitoxins, while of the greatest value when used as curative agents, or immediately following exposure to disease, do not confer an immunity lasting much longer than six weeks, for horse blood is a substance foreign to the human body and is quickly eliminated.

By a different process an immunity lasting several months or years may be produced, a process in which the disease-producing bacteria themselves are injected into the human body. The bacteria responsible for a given disease, typhoid fever, for example, are grown in an incubator upon meat broth, as were the diphtheria bacilli. The bacteria are separated from the broth, killed by heat, estimated as to numbers by comparison with the red corpuscles in normal human blood and put up in measured doses. The "bacterin" is injected into the human body and produces an extremely mild case of typhoid fever, so mild that it causes no inconvenience to the person vaccinated, and yet sufficient to stimulate the body to the production of the antidote, a substance that will destroy typhoid bacteria. Since this protecting substance is formed in human blood, which is not a foreign substance, it will not be as quickly eliminated as was the horse blood, but will remain in the body for several years, always ready to destroy any living typhoid bacteria which may enter it.

It then will be apparent that while the typhoid vaccine is of great value for immunizing purposes, it is of little value in curing the disease itself, since the vaccine is views were shown, also, of the process of manufacture as a poison and not an antidote.

This difference in action between the bacterins and antitoxins is found to be quite general. The antitoxins do not produce a lasting immunity, but give wonderful results when used to conquer disease already under way. The bacterins are of little value for curing disease, but they give us a protection against disease frequently lasting many years.

The lecture was illustrated by lantern slides. Many conducted at the works of the H. K. Mulford Co., Glenolden, Pa.



Society of Automobile Engineers

• • Pennsylvania Section • •

JOHN W. WATSON, Chairman

A. K. BRUMBAUGH, Secretary
Autocar Co., Ardmore, Pa.



THE January meeting of the Pennsylvania Section, S. A. E., was held at the Engineers' Club, Thursday, January 25th. The paper of the evening was by Professor E. H. Lockwood, Assistant Mechanical Engineer, Sheffield Scientific School, Yale University; his subject being "Power Losses in Pneumatic Tires." Professor Lockwood has made a series of tests on a light Six touring car and presented the results of these tests in his paper. He analyzes and separates losses in the various elements of the car chassis and is able to throw considerable light on the variation of power loss with air pressure in tires and also the variation in the several types of pneumatic tire construction.

The discussion was lively and interesting and will appear at length in the Bulletin of the Society of Automobile Engineers.

The next meeting of the Pennsylvania Section,

S. A. E., will be held on Wednesday, February 21st, at the Engineers' Club at 8.15. The speaker of the evening will be Mr. Joseph A. Steinmetz, whose subject will be "Automotives in War."

Mr. Steinmetz has made a study of the use of internal combustion engines by the belligerents in Europe and has an especially fine collection of photographs of the various applications of motor power. His collection covers army transport, aeroplanes, submarines, aerial defense guns, motor sleds, mobile searchlights and the "Tanks" used by the British. Slides have been prepared and the entire collection will be shown on the screen.

This should be a most interesting meeting, particularly since we will have present several authorities along this line who will be qualified to discuss the subjects presented.

Power Losses In Pneumatic Tires

By E. H. LOCKWOOD

ASSISTANT PROFESSOR OF MECHANICAL ENGINEERING, SHEFFIELD SCIENTIFIC SCHOOL, YALE UNIVERSITY

AN apparatus for power measurement at the rear tires of an automobile was installed at the mechanical laboratory of the Sheffield Scientific School in 1913.

A description of this apparatus, with an outline of a proposed method of rear wheel testing with typical examples, was presented at the winter meeting of this Society in January 1915.

During the summer of 1916 a calibrated motor was attached to the drums for the purpose of measuring the internal friction losses of tires and transmission system when driven by an external source. This addition to the apparatus led to a revision of the method of testing and the form of report of results, all aimed to give greater completeness and accuracy.

Considerable attention was paid to measurement of the internal friction losses, and many experiments were made on a six-cylinder chassis* of recent design. In connection with this work a series of tests was made on various elements which might affect car internal resistances, such as speed of car, inflation pressure in tires, load on the axle, and material or construction of the tire.

* A 6-30 Chalmers loaned by the Chalmers Motor Co.

The information derived from these tests has proved so interesting that the principal results are now presented to this Society for discussion. The experiments have the limitation of being made on one size of tire only, and no claim is made that the entire question of tire resistance has been solved.

The method of obtaining the rolling resistance was to anchor the car with either pair of wheels on the center of the test drums, and then rotate the latter by means of the calibrated motor. Two readings were needed, one with the car on the drums and one with the car removed, when the difference in power measures the rolling resistance of a pair of wheels. It has been found possible to avoid calibration errors in this operation by the use of the absorption dynamometer on the drum shaft, adding enough resistance by the latter so that all meter readings are duplicated when the wheels are removed. The dynamometer then measures the equivalent of the rolling resistance of the wheels. The available range of speed of the motor is from 40 to 20 miles per hour at the circumference of the drums, and its maximum power is 15. The diameter of the drums is such that 300 revolutions are equal to one mile.

(Continued on page 95)



American Society of Mechanical Engineers + Philadelphia Section

EMMETT B. CARTER, Chairman

W. R. JONES, SECRETARY
Eng. Dept. Univ. of Penn.



THE BY-PRODUCT COKING INDUSTRY

ON February 1st, a very interesting and well attended meeting of the Society was held jointly with the Franklin Institute in the Franklin Institute Auditorium.

The subject, "The By-product Coking Industry," was very ably handled by Mr. C. A. Ramsburg, Vice-president of the H. Koppers Co., of the Pittsburgh By-product Company, Pittsburgh, Pa.

The lecture treated of the design, construction and operation of the modern by-product plant, coal used in by-product coking; coke structures as affected by coal; conditions affecting the efficiency of operation and recovery; future of the industry. Special attention was devoted to benzol and benzol recovery.

The lecture, which proved to be intensely interesting, was illustrated throughout by lantern slides and moving pictures.

DESIGN, CONSTRUCTION AND EQUIPMENT OF A MODERN MILITARY AEROPLANE

On March 15th, there is scheduled another joint meeting of the Franklin Institute when Jerome C. Hunsaker, Eng.D., Assistant Naval Constructor, Navy Department, will give a paper upon the subject of "Design, Construction and Equipment of a Modern Military Aeroplane."

The paper will consist of a general discussion of the principles of aeroplane design, and the application in modern naval and military aeroplanes.

COMPENSATION OF CIVIL ENGINEERS

The December issue of the *Proceedings of the American Society of Civil Engineers* publishes in full a financial report of their special committee to investigate conditions of employment of and compensation of civil engineers.

The first chart shown plots the yearly compensation against the years of experience. The curve is made from the answers of over 6000 Civil Engineers.

It is notable that the line of average yearly compensation continues to go up until the engineer has had 31 years of experience at which time it falls off gradually until the end. Assuming that the engineer is 22 years old at the beginning of his career, it would mean that the peak earnings of a civil engineer would be at the age of 52. This point of the curve represents \$8810.00 as being the average compensation of 52 engineers, each of whom have had 31 years of experience.

Another interesting chart is given where the yearly compensation is plotted against years of experience. Two curves are plotted, one giving the average compensation of graduates, and the other giving the average compensation of non-graduates.

It is notable that the non-graduate starts out with the higher salary, but is overtaken and passed by the graduate within the first ten years of experience. After forty years of experience, the two curves of graduates and non-graduates approach. The highest compensation of graduates is \$8000.00, and the highest average compensation of non-graduates is about \$6000.00.

A comparison is made of the average compensation again by different classes of service as follows:

No. of Replies.	Nature of Service.	Average yearly Compensation
387	States and Counties	\$2735.00
575	National Governments	2899.00
764	Municipalities	2994.00
262	Technical Schools	3240.00
814	Railroads	3335.00
2198	Private Companies	4240.00
620	Consulting Engineers	6737.00
165	Contractors	7678.00
5785	Total General Average	4032.00

It will be noticed that contractors, consulting engineers and private companies offer the best pecuniary inducements to the engineer.

THE PUBLICATION COMMITTEE APPRECIATES THE COÖPERATION OF THE MEMBERS OF THE AFFILIATED SOCIETIES. IT IS HOPED THAT ALL OF THE MEMBERS WILL TAKE A PERSONAL INTEREST IN FORWARDING TO THEIR ASSOCIATE EDITOR SUCH ITEMS AS THEY MAY HAVE AVAILABLE.

American Institute of Electrical Engineers ♦ Philadelphia Section

H. P. LIVERSIDGE, Chairman

W. F. JAMES, Secretary
1442 Widener Bldg.

THE JANUARY 8th MEETING

THE efforts of the Publicity and Attendance Committee and the resumption of the "Long Table" brought to the informal dinner the largest attendance to date, fifty-eight members and guests to be exact. This is encouraging and we look forward to even larger attendance at future "Long Table" dinners.

When Chairman Liversidge called the meeting to order at 8.15 P.M. one hundred and twenty were in attendance and listened with interest to the paper of the evening, "Industrial Engineering," prepared by Mr. C. J. Russell, of the Philadelphia Electric Co., and read by Mr. John Meyer, Mr. Russell being unable to attend owing to illness.

Mr. Russell's interpretation of the subject was unusually broad and he convincingly brought home to the engineer the great responsibilities along the line of proper and economical use of the natural resources of the country, warning against the future competition to be expected from the European people, who, by reason of the great war, have made great strides in the development of the industries and the elimination of wasteful methods. Mr. Russell impressed upon the engineer the patriotic necessity for the recommendation and practice of only such methods and the promotion of only such projects as are found to be economically sound and in a broad way beneficial to the development of the country as a whole.

The discussion which followed brought out specific instances of the great wastefulness of past and present methods and showed a general appreciation of the necessity for the individual and collective efforts of the engineer being made along the lines suggested by Mr. Russell.

JOINT MEETING WITH FRANKLIN INSTITUTE, FEBRUARY 8, 1917

At the Hall of the Franklin Institute, 15 South Seventh Street, at 8 P.M., Alexander Gray, M.Sc., Professor of Electrical Engineering, Cornell University, will present the subject "Modern Dynamo Electric Machinery with Special Reference to Power and Traction Uses." This is an interesting subject and the speaker is an authority on the subject. Come early if you expect a seat.

THE REGULAR FEBRUARY MEETING

There are fifty to sixty Student Members of the Institute in and about Philadelphia and many students of engineering not yet identified with the Institute. The Section has never fully realized its responsibilities to these men and the February 12th meeting has been planned as "Students' Night." We promise an interesting evening not only for the students but for the other members of the Section. A detailed notice will of course be sent to all and we expect a "full house."

American Society of Heating and Ventilating Engineers ♦ Eastern Pennsylvania Chapter

JOHN D. CASSELL, Chairman

GEORGE W. BARR, Secretary
Land Title Building

THE January meeting of the Society was held at the Engineers' Club on January 11th. No technical paper was scheduled for that meeting as it was considered advisable to devote the meeting to a discussion of the plans for the annual meeting which was to be held in New York on January 16th, 17th and 18th.

The Chapter decided to consider the Hotel Astor as its official headquarters and all members were urged to be present on the dates mentioned.

The annual meeting of the Eastern Pennsylvania Chapter is to be held on March 8th and the election of new officers will take place at that time. The Membership and Meetings Committee was instructed to arrange for a banquet on March 8th and Messrs. O'Connell, Nesdahl and

Anderson were appointed on this Committee, in order to assist in developing the plans for the banquet.

Mr. H. A. Terrell was appointed chairman of the Nominating Committee and Messrs. H. L. Roberts, Lee Nusbaum, William Wilcox and August Giger were appointed to serve on this Committee with Mr. Terrell.

A number of members of the Eastern Pennsylvania Chapter attended the annual meetings of the Society in New York, these meetings being held in the Engineering Societies' Building at 39th Street and Fifth Avenue.

Mr. John D. Cassell, President of the Philadelphia Chapter, read a very interesting paper at one of these meetings, in which he described the heating and ventilation of the Philadelphia schools.



ILLUMINATING ENGINEERING SOCIETY

Philadelphia Section



ROBERT B. ELY, Chairman

T. ELMER MOON, Secretary

A REGULAR Meeting of the Philadelphia Section will be held Friday evening, February 16, 1917. Mr. L. C. Porter, of the General Electric Company, Harrison, N. J., will speak on "Flood Lighting." Dr. Hoadley will resume his talk on the "Fundamentals of Illumination."

The regular monthly meeting of the Philadelphia Section of the Illuminating Engineers' Society was held on Friday evening, January 19, 1917, at the Engineers' Club, preceded by a very successful dinner.

At the dinner, Mr. H. A. Horner gave a short but interesting talk on the "Relations Between the Architect and the Illuminating Engineer." The main theme was the common ground of the ideal of the beautiful on which they should accord; the architect on beauty of design, the illuminating engineer on beauty of illumination.

Preceding the paper of the evening, Mr. F. H. Gilpin, continued the series of talks on the "Fundamentals of Illumination." The talk was devoted mainly to an explanation of the definitions given in the 1916 report of the Committee on Nomenclature and Standards for "candle," "candle-power," "lumen," "mean horizontal candle-power," and "mean spherical candle-power" and their graphic relation to each other. The discussion of this subject was active and instructive.

Mr. J. D. Lee then presented a talk on the "Development of Gas Lighting Fixtures," by Messrs. S. Snyder and J. D. Lee of the United Gas Improvement Company.

It has been of comparatively recent years that gas companies began to devote attention to the direct sale of fixtures to their consumers. Previously the field was left almost entirely to the efforts of dealers and manufacturers.

After the gas industry awakened to the possibilities presented in extending and holding the lighting portion of its business, through the direct marketing of fixtures, for a number of years little attention was paid to the variety of design, artistic effect and substantial construction in the fixtures offered for sale.

This does not mean that fixtures of substantial construction and decorative design were not obtainable, but it does mean that those of the higher types were handled almost exclusively by dealers.

The gas companies apparently considered fixtures merely as supports for lighting units and were content with displaying and offering for sale fixtures of the cheapest workmanship, generally of inartistic design and frequently of faulty construction.

Even with the improvement of light units little advancement was made in the methods employed by gas companies towards interesting their consumers in the better types. Not until the gas companies began to feel

the inroads made by competitive illumination did they arouse themselves from this apparent indifference to the demands of the public and determine to employ methods which would more greatly stimulate the sale of gas lighting fixtures.

With the coöperation of the fixture manufacturers, such decided advancements have been made that to-day gas lighting fixtures are obtainable which not only meet the specifications of our Association, but harmonize with the surrounding home furnishings and are of unquestioned merit and artistic beauty.

There is an extensive field for the sale of gas lighting fixtures in every territory covered by gas mains. It is believed that most lighting installations over five years old are "out of date" and their replacement with fixtures of modern design is well worth intensive effort; therefore it is extremely important and necessary that the gas companies systematically and intelligently develop this vast market lying at their doors.

The concerted effort on the part of the gas companies and the fixtures manufacturers to offer for sale only such fixtures as will meet the requirements of a discriminating public, in workmanship, material and design, will place gas lighting on the high plane the gas industry would have it occupy.

Gas lighting is a subject worthy of our best efforts and nothing can further this interest to a greater extent than developing the art of good fixture design. The development of gas fixtures in the past few years makes it possible to secure artistic effects which will meet every requirement.

The question of combination fixtures has been frequently discussed, and we may properly add to this feature, a suggestion that gas companies eliminate the effort to match up the electric units on combination fixtures and hold to side wall outlets using straight gas. The growing appreciation of the value and artistic effect of bracket lighting improves the opportunity for gas lighting being given the preference in the residence.

The improvements that have been made in gas units, we feel, are sufficient to offset the improvements made in electric units. If dual installations of gas piping and electric wiring are expedient because of competition, there is no reason why the gas industry should seek to improve the combination fixture or in any wise encourage its continued use. There is every reason why a residence should be piped for gas, and such outlets as are required for lighting might just as properly be straight gas. The effort should be made to obtain the locations on the side walls in bed rooms, dining rooms, halls, and living rooms, in such positions as are usually provided for bracket lighting,

together with baseboard and floor outlets to accommodate table portables and floor standards.

The thought is not to evade the competition with electric fixtures so much as it is to meet this competition squarely with gas fixtures of design that compare favorably. Here, again, our better judgment should teach us to avoid that extreme in which the appeal is made solely by a quasi artistic effect. There are certain fixtures which are useless as light sources, and the unhappy owners are compelled to depend upon other units for comfort and illumination. We may in time educate the public to discriminate in favor of the more sensible fixtures, while at the same time mould the desire for appropriate designs.

Intelligent buying can only be the result of the dictates of this knowledge. Appropriate designs of fixtures are in the last analysis dependent upon a knowledge of the interior decoration of which they are intended to form a part. Culture and refinement are distinguished by a display of taste, which finds its best expression in the harmony of decoration. The problem resolves itself into this question: Are we to depend upon the caprice of individual whim and fancy, or are we to take the trouble to suggest that which is fitting and appropriate? In selling it is essential to know the value of certain designs which are applicable to a particular interior furnishing. On special occasions it has been the practice to obtain the services of the manufacturer to supply special designs. Here, again, experience has taught that much that was considered special could have been obtained from regular stock if fixtures of good design were offered generally. It is such fixtures that we advocate for display.

We have learned that in the development of the art of lighting two things are essential—to provide adequate illumination and to insure eye comfort. The growing appreciation of local lighting, as evidenced in the popularity of table portables, suggests the tendency toward specific or local illumination, rather than general or overhead lighting. Particularly in the home, the cozy effect which makes one room appeal to us more than another is the fact that it is lighted with well screened light sources. The popularity of the dining room dome in the past may be traced to this effect. The present popularity of the floor standard indicates the appreciation for local lighting. It is for these reasons we weigh our conclusion, that if side wall brackets are intelligently placed they will be used in preference to the most elaborate electric fixture that obtrudes itself in the center of the room.

UPRIGHT vs. INVERTED FIXTURES

The introduction of the C. E. Z. burner during the past year, and the campaigns of education incident to its introduction, have been responsible for a change from inverted to upright fixtures. Much ingenuity has been displayed in the design of the new upright fixture that characterizes it as different from the former upright fixtures that did service for the open flame gas burner. It would be well for us to consider closely the chief feature of this distinc-

tion. The modern fixture is more logical in that its structure is built up in the body of the fixture itself, whereas formerly, the fixtures were constructed with flimsy arms to support extremely large glass globes, while contrasted to the latter we note the substantial mould of the body of the fixture, which carries gracefully the new light units.

Even with designs of a lighter mould we note the tendency to provide structural balance—light graceful arms supporting candle effects.

The introduction of new light units, following so closely as they did one upon another, has been responsible for the distortion of many otherwise satisfactory installations. As an illustration, fixtures, many of which were well designed, were found to be equipped with a variety of units, none of which were suitable or conformed to the fixture design.

How much more satisfactory is the installation illustrated showing the same fixture with candle effect and suitable shades!

For the purpose of our example, we have taken one of the latest designs of fixtures, but the fact remains nevertheless that the public, if left to its own judgment, is very apt to mistake the value of certain units. The importance of having fixtures appropriately equipped cannot be too strongly emphasized.

In the matter of holders, the appearance of a fixture is marred or preserved, as the case may be, due to the shade holders used.

As an integral part of the fixture, the design of the holder should conform to the period and design of the fixture.

The development of semi-indirect lighting fixtures and the prominence of glass dishes and bowls in these units is best illustrated in the method employed in using the light source. The new burners adapt themselves well to this form of fixture.

At first, the reflex unit was supported by a pendant and the dish or bowl hung on chains.

With the introduction of the Kinetic burner and the many types of these fixtures, a supporting structure was developed which supplied the gas ways as well as a support to a metal band holding the dish itself. The limitations of this feature eliminated those dishes not having a flange to engage the metal band.

Many beautiful designs in pressed glass bowls often suggested a reason for their use, but until recently no fixture was available. An adjustable hanger was developed, which permitted a bolt to pass through the drilled holes on the sloping slides at any angle from 0° to 90°. In this way the varying designs of bowls were automatically taken care of and units of much grace and beauty were made available and interchangeable.

Splendid illustrations of the various fixtures and burners mentioned in this article are given in the February *Journal of the National Commercial Gas Association*.

Resolutions were adopted on the deaths of Dr. Wendell Reber and Mr. F. N. Morton, both formerly active and interested members of the local section.

POWER LOSSES IN PNEUMATIC TIRES

(Continued from page 90)

Quite sensitive readings may be made in this way, enabling small variations in rolling resistance to be measured. One possible criticism of its accuracy may be made, namely, an increase of drum friction when the weight of the wheels is added to that of the drums. Careful measurement of the drum friction when running idle showed 4 pounds at the drum circumference at 20 m. p. h. and 6 pounds at 40 m. p. h. The drums weigh about 3000 pounds and an average pair of wheels about 1500 pounds. It is certain the friction does not increase in proportion to the weight on the drum bearings, and the assumption that the drum friction is constant at different loads cannot involve much error.

ROLLING RESISTANCE AT VARIOUS SPEEDS

One surprising result of all measurements of rolling resistance, at speeds from 2 to 40 miles per hour, has been the very slight increase of resistance at the higher speed. With some cars the increase of resistance is less than the observation errors. In other cases the increase amounts to five or ten per cent.

In reporting values of rolling resistance, the observations have been made at either three or four speeds covering the entire range, finally using the average of all the readings.

As an example of the amount of variation of resistance with speed, the following tests are reported with readings exactly as recorded:

Rolling Resistance of Front Wheels	
Car No. 1; Tires 32 x 4 Goodyear Cord, Inflation 60, Load 1120.	
Rolling resistance, 20-40 m.p.h., 11.7, 11.7, 13.8	
Rolling resistance, 20-40 m.p.h., Average, 12.4 pounds.	
Car No. 2; Tires 32 x 4 plain fabric, Inflation 55, Load 1145.	
Rolling resistance, 20-40 m.p.h., 24.1, 25.0, 23.5, 24.4	
Rolling resistance, 20-40 m.p.h., Average, 24.25 pounds.	
Car No. 3; Tires 35 x 5 Goodyear cord, Inflation 60, Load 2100.	
Rolling resistance, 20-40 m.p.h., 33.0, 33.6, 34.2, 33.8	
Rolling resistance, 20-40 m.p.h., Average, 33.65 pounds.	

These cars differed considerably in rolling resistance, but in every case the speed of the car had little or no effect on the result. Rear wheel tests were made confirming the results obtained with the front wheels, hence the conclusion from these tests that the internal rolling resistance of an automobile is practically constant at all speeds up to 40 miles per hour.

DISTRIBUTION OF POWER LOSSES

The measurements described give as a result the total rolling resistance of the front tire and bearings, or of the rear tires and all transmission losses up to neutral gear.

By an independent measurement a separation can be made of the tire loss from the bearing and transmission loss. This is accomplished by jacking up the wheel until the contact between the surface of the tire is just sufficient to revolve the wheel. In this way tire resistance is prac-

tically eliminated, leaving only resistance due to bearings and transmission.

The internal power losses of the six-cylinder Chalmers chassis have been determined in this way. The tires are 32 x 4, load on front wheels 1145, load on rear 1545 pounds, tire inflation 75.

	Lbs.	Per cent.
Rolling resistance, front tires only.....	18.2	= 31.2
Rolling resistance, rear tires only.....	17.7	= 30.3
Rolling resistance, front bearings	4.7	= 8.0
Rolling resistance, rear bearings and transm.	17.9	= 30.6
Rolling resistance, total for above.....	58.5	= 100.

Dividing the above four items into groups, we find that the tires alone cause 61 per cent. of the total resistance, while the axle bearings and transmission up to neutral consume only 39 per cent. The conclusion is that the tires are responsible for nearly two-thirds of the power lost in the car itself.

The above values are averages for speeds from 20 to 40 miles per hour, and as before stated, the resistance changed little with the speed.

TIRE RESISTANCE AND PRODUCTION OF HEAT

The discovery that 61 per cent. of the internal power loss of this car is expended in the tires, leads naturally to what becomes of this power.

It is probable that friction of the material within the tire structure is continually taking place, due to flexure at the contact with the road. This absorption of work and production of heat is similar to the friction brake, except that the friction is produced by bending the fabric, not by sliding it.

Assuming the truth of these assumptions, it ought to be possible to calculate from the work absorbed the amount of heat generated, also the temperature of the tire surface when it reaches thermal equilibrium. The solution of this problem is worked out like a hot water radiator, or, rather, as the wheel is revolving, like a hot blast heater.

These tires have 5.83 sq. ft. of surface, and the force of resistance at the circumference is 8.85 pounds. At a speed of 30 miles per hour there will be generated 1810 B. t. u. per hour, and to dissipate this heat to the air will require a rise of temperature of 39° F. above room temperature, based on a heat transfer coefficient of 8 B. t. u. per degree per hour.

This calculation was made in advance of any experiments, but was later verified by running one of the 32 x 4 tires for half an hour at 30 miles per hour, after which the car was stopped and the surface temperature taken with a mercurial thermometer. The room temperature was 70° F. and the tire temperature was 107.5°, or a rise of 37.5° as compared with the calculated rise of 39° F.

This experiment confirms the theory that tire resistance is caused by flexure of the material, and leads logically to the conclusion that resistance will be increased by underinflation and by overloading.

INFLATION PRESSURE AND LOAD

Of the factors affecting rolling resistance, inflation pressure is perhaps the most important. Very considerable changes of resistance may be caused by moderate changes of pressure.

The load carried by the tire is also an important factor, which must be considered along with the inflation. It seems probable that for a given load there is a region of inflation below which the resistance increases very fast.

This relationship can best be shown by a series of characteristic curves, where rolling resistance is plotted against inflation for a number of loads. A diagram showing an incomplete series of such characteristic curves for 32 x 4 tires, is given on p. 9.

The influence of inflation pressure is clearly shown in curve A, which represents the rolling resistance of the rear wheels under normal load with fabric tires. With reduction of inflation pressure from 80 to 30 pounds the rolling resistance increases from 30 to 45 pounds.

When the load on the wheel was reduced the rolling resistance decreased from 30 to 25 pounds under high inflation pressure. Reduction of pressure caused an increase of resistance in this case but not quite as pronounced as in the first curve. Curve B shows the rear wheel resistance under light load.

Curve C shows the resistance of the front wheels under load equal to that on the rear, and displays the same characteristics as curve B. The unfirmly greater resistance of curve B is due to the transmission system connected with the rear wheels.

An approximate calculation of the increase of power caused by under inflation can be made from the above experiments. From the diagram, p. 9, the total rolling resistance at 80 pounds pressure, front and rear wheels combined, is 51.9 pounds, while the corresponding value at 30 pounds inflation is 72.5 pounds. Adding to these values the wind resistance calculated for 25 m. p. h. (30 pounds) the total car resistance for the two cases is found to be 81.9 and 102.5 pounds. The conclusion is that an increase of power amounting to 25 per cent. may be caused by very much under inflated tires.

CORD VERSUS FABRIC TIRES

Only a limited number of tests of cord tires have been made under conditions permitting accurate comparison with fabric tires.

One such comparison is shown on diagram, p. 9, curve D, where a cord tire, 32 x 4 was tested under exactly the same conditions on the front wheels for the whole range of pressures.

The characteristics of this cord tire are greatly reduced resistance loss and ability to run at low inflation without much increase of resistance.

While these experiments point to the value of cord tires for reducing tire losses, more numerous and exhaustive tests are required covering a wider scope.

S. A. E. AERONAUTIC SESSION, NEW YORK,
FEBRUARY 9th

To S. A. E. MEMBERS,

Gentlemen: The first meeting of the Society devoted entirely to consideration of aeronautic engineering subjects will be held at S. A. E. Headquarters on the afternoon and evening of February 9th, the second day of the First Pan-American Aeronautic Exposition.

From this it should not be inferred that the papers to be presented will be of interest to aeronautic engineers only. No automobile engineer can afford to ignore developments in the aeronautic field of such vital importance in the national preparedness program, and of such commercial moment that it is expected that some fifty million dollars will be spent in this field during the current year.

You are urged therefore to make immediate plans to attend the meeting.

The program will include an afternoon session devoted to consideration of aeronautic standardization subjects, with papers and discussion by engineers conversant with the needs and possibilities in this line of work. One of these papers entitled "Necessity of Standardization in Metal Parts for Aeronautic Use," by F. G. Diffin, will be printed in the January BULLETIN. A second paper by J. J. Rooney on suggested standard performance tests of airplanes, has been promised.

The evening session will include two papers on subjects of great importance, by authorities in their respective lines.

1st PAPER "Aerial Navigation Over Water," by Elmer A. Sperry, (printed in December BULLETIN).

2nd PAPER "The Evolution of Airplane Wing Trussing" by Professor F. W. Pawlowski of the University of Michigan.

Come yourself and bring with you some engineer interested in aeronautics. It will be the best possible opportunity to become acquainted with new and old members of the Society working in this important field.

TICKETS FOR AERO SHOW

Each member of the Society who applies in person at S. A. E. Headquarters on February 7th, 8th or 9th, will receive two tickets good for admission on February 8th, 9th and 10th to the Aeronautic Show to be held at Grand Central Palace, February 8th to 15th. No tickets will be mailed to members.

Fraternally yours,

1917 Meetings Committee,

DAVID BEECROFT, *Chairman*.

Members of the Engineers' Club, who are not S. A. E. members are invited to this meeting. Arrangements will be made for them. Call Pennsylvania Section Secretary.

Engineering Articles of General Interest

CARE OF MARINE BOILERS

BY EDWARD B. FRASER

BOILERS are the most expensive and perishable parts of the machinery of a steamship, often requiring to be replaced twice, and sometimes three times, during the life of a vessel. Deterioration and decay begins as soon as the boilers are put in use, and are only partially prevented by care on the part of designers and engineers. At the present time the demand for large and fast steamships necessitates the use of boilers of great size and cost. The attention of builders and owners is therefore directed to keeping this portion of the machinery up to the highest point of utility for the largest period at the least expense.

Twenty years ago eight years' work was considered a good average for a marine boiler, but the period of usefulness has been increased about 100 per cent. in recent years. This gain is due in a measure to the improved design and construction; but more probably to the more intelligent care bestowed upon them by modern engineers.

The first and simplest thing to guard against is external corrosion. This arises from various causes, drips from leaky decks, leaky screw staybolts, leaky handhole plates joints, stuffing boxes, etc., and from a cause so apparent that it would not be noted if it did not occur so often, namely, the neglect to waterproof portions of the boilers directly under hatch openings.

There is no good reason for the existence of any of these causes of corrosion, yet they do not exist and create a constant demand for the "soft patch." The most serious point of external corrosion is the front of the ash pit and the adjacent portion of the boiler head. The use of fire tools, wetting down of ashes and other causes conspire to render corrosion at this point very rapid.

It may be counteracted in part by the persistent use on the ash pit fronts of the waste oil and grease from the engine room. A better method of protecting this part of the boiler, though seldom applied, is to fit soft patches or wearing plates of $\frac{5}{16}$ -inch iron over the seams connecting the furnace to the front head, and extending over the lower part of the front head to take in the front seam of the shell. This should be done when the boiler is new, and, although these wearing plates will last only a few years in active service, their renewal is simple and inexpensive; therefore to be strongly recommended. Four years' wear in hard service has been obtained from the wearing patches by keeping them smeared with the waste oils from the engine room.

With ordinary intelligence bestowed upon the care of marine boilers, there is no reason why their period of usefulness should be shortened by external decay. Internal decay is a much more serious matter. The chief causes of trouble inside boilers are use of dirty water, greasy water, cold feed water, imperfect circulation and contracted water spaces. Using steam at a pressure of 160 pounds per square inch involves difficulties that did not exist at 75 pounds per square inch. At the latter pressure a little supplementary feed from the salt water inside of the condenser would give a coating of lime inside the boiler, prevent pitting and the oil coming with the feed water would rapidly rise in the slightly brined water to the surface and could be cared for by the scum valve, but while a sixteenth of an inch scale on a back tube plate would not cause trouble at a working pressure of 75 pounds per square inch, at 160 pounds another condition of affairs exists. The tube plates having been thickened for increased temperature, the tube ends will leak from a very slight deposit on the tube plate.

A spray from the leaky tube end, wetting the particles of ash, coal and dust carried by the draft, forms a deposit on the other tube ends and the furnace is rendered useless. If two furnaces are common to one chamber, both are disabled; much disagreeable labor is entailed expanding leaky tubes, and this must be done repeatedly until there is an opportunity to thoroughly clean the boilers.

There is also danger under forced combustion of the tube ends leaking enough to cause a back draft from the furnace into the fire room.

Corrugated furnace crowns are seriously injured by even thin scale and it will be found that corrugations near the middle of the grate suffer most. At this point the repeated opening of the furnace doors and consequent change of temperature causes the scale to crack, a new coating is formed, is again cracked, and so on repeatedly until, in some cases which have come under the author's observation, the scale for twenty days' run had formed in leaves attached to corrugations like the leaves of a book to the binding with the open edges of the leaves, about one inch over all, toward the front of the furnace, and the attached edges about $\frac{1}{8}$ inch thick toward the back. This shows that the evaporation is much greater at this part of the boiler. In parts of the boiler where less active generation of steam takes place, pitting is sure to follow. The under sides of boiler tubes suffer most, also the sides of furnace about the line of the grate bars, and sides and bottom of combustion chamber. The pitting in these places is rapid and frequently unobserved in the earlier

stages, the pitted part being covered with black, moderately hard oxide, which, being removed by thorough washing and scraping discloses the true condition of the metal attacked.

To prevent this overheating and pitting, from the presence of oil or grease, many remedies have been used with varying results. Filters of various kinds are among the most successful devices, sometimes applied on the suction side and sometimes on the discharge side of the feed pumps. These filters are of various metals; sponges, blankets, coke, charcoal, gunnysacks, horsehair, tan bark, hay, etc., each being strongly advocated by its particular selling agent, but the results depend more upon the care and judgment exercised by the engineer than upon the material of which the filter is made.

The filter which presents the greatest surface in a given space, which can be readily replaced, and the material for which can be obtained at any port at small cost, will commend itself to engineers; but a filter tank filled with ideal material will mechanically trap only a small percentage of grease if the filtering material is not frequently cleaned or renewed.

The designer of a filtering plant should bear in mind that the location, accessibility and facility with which covers and interiors can be removed and replaced is of vital importance.

Efforts have been made to catch the grease in the main engine exhaust pipes, hoping thereby to keep the condenser as well as the boilers clean, but reports are conflicting as to the success of these devices. Feed water heating arrangements assist materially in getting rid of the grease. Cold feed water is injurious to boiler shells, furnaces and furnace seams, and water should be heated to within a few degrees of the steam temperature before being discharged into the boiler; but while this is generally done, it is, strange to say, not a universal practice. Heating the feed water by direct contact with steam is so simple and satisfactory that it seems to meet all requirements.

Efforts have been made to neutralize the effects of oil in boilers by injecting sal soda, caustic soda, lime water and potash with the feed water; but, as the best cylinder oils now in use are pure mineral oil and do not saponify, the results have not been satisfactory.

Zinc slabs in parts of the boiler showing decay seem to retard it somewhat, though a large quantity, sometimes amounting to tons, has been used without satisfactory results.

It will be found that boilers fed by an independent feed pump with feed water from a surface condenser, aided by an evaporator, filter and heater, have very little tendency to pit below the line of the grate bars when an efficient system of mechanical circulation is maintained. The use of hydrokineter warms the water in lower parts of boilers when getting steam, but constant circulation is necessary, especially under banked fires, and the water should be pumped continually from lower front end of boiler to upper back end.

The value of this simple method is greatly underestimated, and on many vessels the pumps are not fitted up for the purpose. Constant circulation by pumping prevents the lower shell seams being strained by unequal expansion and reduces pitting below the grate line to a minimum. The benefit derived from constant circulation below the grate level seems apparent when we consider how little pitting takes place between the grate line and top of combustion chamber. In two-furnace boilers pitting below the grate line is greatly in excess of that in three-furnace boilers, a difference due to the better circulation maintained in the latter by the location of the middle furnace.

If tubes are placed too close together, cleaning is difficult and tubes are liable to be burned at the back ends from an insufficient supply of water to tube plates. Tubes placed to give 50 per cent. water surface to tube plate give practically no trouble, but if placed to give only 40 per cent. are likely to make the water in boilers foam and give needless trouble to keep back ends of tubes tight in top sheets.

When the tubes are overcrowded in boiler various methods are resorted to, such as ferrules and cements, to prevent leaking of tube ends. However, all such devices are merely temporizing with the difficulty, which exists primarily in the defective design.

On the flame side of the furnace decay takes place at the point of contact with the brick wall, and as the deterioration covers a large surface it is apt to escape detection until the plate is quite thin. By placing thin sheet iron between the bricks and the furnace plate each time the bridge wall is rebuilt the decay may be retarded. Around the manhole joint in the interior surface of the plate pitting occurs partly from the presence of sulphur in the rubber gaskets and partly from rapid buckling upon the surface of the plates.

The wear of boilers depends much upon the character of the service in which the vessel is employed. Tug boats, bay steamers and coasters, in the order named, seem to suffer more than ocean steamers. Irregular application of heat, lying under banked fires for long periods and irregularity of washing out boilers will account in a great degree for this difference.

The care of a marine boiler when not steaming is of great importance. If empty, it should be quite dry. If it contains water it should be quite full and have no leaks. Sudden stopping of engines, without an independent air pump to care for the steam, is a constant source of injury to boilers, as it is difficult to check the pressure without notice. There is, of course, no difficulty with independent air pumps to care for the steam.

The use of force draft has added to the difficulty of caring for boilers, especially with the closed fire room system, as the admission of cold air when the fire doors are open is the worst possible treatment for back connections and tubes. The induced-draft system is little, if any, better, either with the fan or the jet in the smokestack. The alternate high and low temperature from the immense heat of the fires and the inrush of cold air when the fires

are replenished demand a very elastic duty from materials and conditions that are the reverse. Forced draft with the closed ash pit system affords better control of the steam-making power and depends less upon the trim of ventilators or direction of the wind, especially in the tropics, where fireroom duty is always severe. It is also free from the great objection of admitting a rush of cold air when the fires are replenished. The main objection to its use is increased length of fireroom required with the ordinary type of marine boiler, but its use in moderation is extending and all the appliances to supply it are of the most permanent and durable character.

This system does away with the difficulties arising from handling coal from different bunkers and discharging ashes which are encountered with a closed fireroom, and the longest voyages may be made with a regularity of steaming impossible with a closed fireroom or natural draft.

The foregoing remarks apply particularly to the ordinary type of marine boiler, but of late years the demand for high pressure and less weight per horsepower has brought into use various forms of watertube boilers, the care of which is important. All that has been said as to the necessity of supplying pure water is more imperative with the watertube boiler than with the older type. Being more flexible, the watertube boiler suffers less from forced draft with closed fireroom, but, being more susceptible to change of temperature and having a small storage of water, will suffer greater loss from a steam-making standstill than if used with the closed ash-pit system.

The life of grates, bridge walls, furnace fronts, depends almost entirely upon the coal used. With Pacific Coast, Australian, Japanese, Chilean and the lower grades of English and Scotch coals, the furnace fittings wear well, the linings of the fronts suffering most when the fire is too near the front. With good grades of Welsh and Pennsylvania coal the wear is much greater, especially if dampers are used suddenly to prevent blowing off steam when it is necessary to stop the engine quickly.

The most used grate bars are the thinnest, and wrought iron is preferable, as this can easily be straightened or pieced out aboard ship, when cast iron ones might not be obtainable.

Breechings, front connections and doors require constant attention when lignite or flancing coal is used, and if not kept in repair add to the consumption of coal and interfere with the draft. With patching and repairing, front connections, doors and uptakes will usually last as long as the boilers; not so with the smokestack. In active service, ten years is a long life, and this again depends on the quality of coal used. If flaming coal is used the smokestack has a very short life—not more than five years with some of the lignites.

The outside of the smokestack is protected by paint, but as yet we know of nothing that would afford real protection to the interior. Some vessels are provided with hoods to protect the smokestack when laid up, but these are seldom used when the vessel is in commission.

It is the custom of recent years to cover the greater part of boiler shells with non-conducting material, covering this in turn with either sheet lead, galvanized sheet iron or painted canvas. If either of these waterproof coverings are permitted to leak the non-conducting material, being porous, absorbs the moisture and causes corrosion. There are numerous non-conducting coverings which, when properly put on and kept waterproof, which is seldom, will last as long as the boiler.

Bottom and surface blow-off valves and feed check valves require constant attention. The scour from the blow-off is particularly bad on the seats of the blow-off valves, and if neglected and permitted to leak entails serious trouble with blow-off pipes. These valves should be ground in or faced up frequently. In using the blow-off at sea, the gradual and the simultaneous closing of outboard and inboard valves will greatly reduce wear on pipes. In these pipes the dynamic effect of the sudden change from cold water to hot pressure and the reverse is very great and will sometimes split the heaviest pipes.

The gage cocks must of necessity be blown through to keep them free, and if the composition contains zinc they last but a short time. The author has renewed them after but three months' wear, when the keys looked more like sponge than metal.

Boilers well designed, constructed of the best materials and equipped with the most approved fittings may be a source of constant annoyance and expense for the lack of intelligent care in the matter of raising steam and blowing off the water. If boilers and pipes are slowly and equally warmed before pressure is raised a most fruitful source of leakage is avoided.

When at the end of a voyage steam pressure is blown off, dampers and doors should be closed and the water left in the boilers to cool gradually, a couple of days if practical, before being pumped out. Attention to these details will be well repaid by the absence of leaks, which are inevitable when boilers are blown out with steam-pressure.

The length of time a boiler may be used varies so much under different conditions that it is difficult to arrive at a satisfactory average. The author can recall two sets of boilers of the same type and in similar service, one set of which was renewed after eleven years of service. These boilers were steam tight, and from the furnace side were apparently as good as ever. Yet the back connection sheets were found to have been reduced in thickness by decay from three-quarters of an inch to barely one-half an inch. Where decayed, the combustion chamber had only about a two-inch space between that and the shell.

The other set of boilers, having 3½-inch to 4-inch water space around combustion chamber, was found to have worn very little at these points, and was continued in use four years longer.

Another marked instance has come under the author's observation where the machinery of two vessels on the same service shows marked difference in wear. The boilers in one vessel required renewal after seven years

of service, while in the other they have now been running sixteen years and appear to be good for many years more. In the latter case the same chief engineer has had charge of the machinery from the beginning of service.

Among the many old boilers which the author has seen repaired he has found that as a rule comparatively little decay has taken place above the bridge walls, and the shells were pretty good except the lower parts, but the furnace lower back connection and lower stays often made me wonder how it was possible for the parts to hang together and stand the pressure test.

With the superior quality of steel available for the construction of boilers at the present time, drilled holes, improved workmanship and the use of corrugated and other elastic furnaces, the life of boilers is much longer than some years ago. Evenly distributed bracing, tube space not crowded, the use of hot filtered feed water and mechanical circulation of water in boilers, with the renewal of tubes, etc., have prolonged the life of marine boilers to nearly twenty-five years as a general thing.

Eternal vigilance is the price of safety in the case of steam boilers, and the engineer who despises small things will be continually beset with small troubles, which in the aggregate will greatly reduce the period of service of boilers and engines.

—*Marine Engineering*

THE MANUFACTURE OF ARMATURE COILS

By D. W. PERRY

IN the manufacture of armature coils in large quantities a simple, accurate and cheap method of construction should be used. It is also important that the tools for duplicating coils already in service be kept, in order that repair coils may be supplied. The repairing of a motor or generator with damaged windings is, as a rule, made by the customer in his own repair shop or in some nearby service station. It is desirable, therefore, that the process of rewinding be made as simple as possible. The coils should be made so that they can be wound readily into the core before the machine is delivered. There should then be no difficulty in repairing damaged windings, for duplicate coils can be obtained from the factory.

There are three general methods of making coils for commercial use, namely, on a mould, on a former or on a puller. The term "mould coils" is commonly used to include coils made over a form which can be rotated on a lathe, but turning only about one-quarter of a revolution at a time, all necessary shaping being done with very little pounding of the conductors. The term "formed coils" is usually meant to include those coils made over a stationary form, all necessary bends being made by the use of levers and mallets and, in general, considerable force must be applied to make the coils take the required shape. The term "pulled coils" includes those coils which are first wound on a shuttle fastened to a lathe, and then pulled on a coil puller to the shape required for winding into the slots.

In comparing the different methods of winding coils it will not be necessary to consider the insulation, as this makes very little difference in the method employed in making the coil. The general method of designing coils is also the same for any type. However, on account of the fact that a more accurate coil can be made on a former than on a puller, the formed coil is laid out with the intention of having all parts of the coil wind the same, that is, to have the top side of the coil wind as tight as the bottom side. This is impossible with a pulled coil. The top side, or side away from the air-gap, always winds looser than the bottom side, or the side nearest the air-gap.

MOULDED OR FORMED COILS

Moulds are made of wood and fiber. These materials are cheap and are easily worked into the right shape and the fiber is tough enough to stand the wear at the bends. The frame or body of the mould is made of wood. The wire space, or the grooves into which the coil is wound, is cut into the wood or, as is the case at bends, it is built up of fiber plates or strips. This wire space is made so that the coil wound in it will have the correct shape. The moulds when in use are bolted on to the face plate of a lathe so that they can be rotated, thus winding up the coil. The moulds for one-coil-per-slot windings, for concentric windings and for diamond-type coils wound with a loose formation (so-called "basket coils") are made so that the coil can be wound up without cutting the wire, the wire space on these moulds being made of such a size as to give the finished coil a dimension that will permit its being wound readily into the slot.

The moulds for diamond-type coils, where a certain definite formation of the conductors in the slots is required, are made different from the above type of moulds. In the latter case the coils are wound in layers and turns. If the wire space were made the size of the finished coil it would be a very difficult operation to keep each wire in its proper place while winding the coil, as the bends place the strain first on one side of the wire space and then on the other. To avoid this the moulds are made for only one wire in width at a time, and the coil is then wound up into sections, each having the same number of turns. The wire is cut after each section is wound and tied; the mould is opened and the section is removed, the moulds being made so that the sections can be removed without distorting them. After winding the required number of sections these are assembled and connected to form a complete coil. This method often necessitates having a number of soldered joints in the coil, which is an objectionable feature, but it is one that cannot be avoided on the mould.

Round wire is the only shape that can be used under all conditions on a mould with any degree of safety. The sharp bends that are made cause square wire or ribbon to turn up on edge and the insulation on the wire is cut through, causing a short-circuit in the coil.

The chief advantage in connection with the use of

moulds is the space required for storage. A new mould has to be made for each coil, and these moulds must be kept to supply repair coils. This means that storage must be found for all these moulds. It therefore soon becomes a very great problem to find room for the vast number of moulds that are the results of an ever-increasing demand for new motors, each requiring some slightly different coil.

Formers have to be made very much stronger than moulds as a rule, because the coils are pounded to shape on them. For heavy strap where great force is required the formers are made of iron, which increases their cost very materially. In order to avoid this expense, where possible, wooden formers are used which are strengthened at the bends with pieces of iron. In this way a very durable former can be made, and one that can be changed more easily in case such a change is necessary to give a better coil.

The strap or ribbon to be wound on the former is cut to the required length and then bent around a pin; the size of which is governed by the size of the copper and also the voltage. In most cases this is the only bend that is made in the copper before being placed on the formers. However, in some cases where very heavy strap is used and the bends are comparatively sharp, the strap is bent to the general shape before being placed on the former, and then by means of levers and a mallet the strap is forced to take the shape of the former.

Very accurate coils can be made on the former. In the first place the coils have been laid out on a drawing board, and in this way the dimensions are obtained for the best coil for the conditions. With a former made to these dimensions, all coils in the set will be correct if a reasonable amount of care is taken in forming them.

A formed coil has the advantage of having a very short coil extension because of the fact that all parts of the coil are formed so as to use the minimum length of copper. By coil extension is meant the distance between the ends of the coils and the core. As the overall dimensions of the machine are very materially affected by this extension, it is sometimes worth the difference in expense to use a formed coil, when another type of coil would have otherwise met the requirements.

PULLED COILS

The first operation in making pulled coils is the winding of the coils on the shuttle. A shuttle is made of wood and fiber. The center block around which the coil is to be wound is made the length of the straight coil. The width is determined by the diameter of the fiber pins at each end. The diameter of these pins depends upon the voltage, the size of the conductor, and upon general conditions encountered in winding. The thickness of the center block depends upon the width of the coil.

The sides of the shuttle are cut longer and wider than the center block, so that when assembled it leaves a slot into which the coil may be wound. The center block is fastened on one of the wooden side pieces, which is se-

cured to the lathe. The other side is secured by the fiber pins at the end of the center block and by a steel pin on the face plate which extends out through the removable side. The center pin has a slot into which a wedge-shaped key is driven, holding the sides up tight. These shuttles are very cheap as compared with the cost of a mould or a former. They can easily be adjusted for a new coil by adding a new center block and, because they are cheap and can be used on different jobs, it is not necessary to store them after the coils are wound, except for standard coils.

The use of the shuttle and puller eliminates most of the soldered joints that are made on mould coils. Since the coil is wound on the straight shuttle and pulled afterwards, the coil can be wound hit or miss, or in layers and turns, without cutting the wire.

The puller gets its name from the operation which it performs. It is a machine so designed that the coils taken from the shuttle can be pulled to the required shape. The straight parts of the coil are pulled to the required angle of throw, and at the same time are given the correct bevel for winding into the slot. The diamond ends of the coil are kicked up to the required height to give the correct winding angle. A skilled operator can pull a small coil in two minutes or less. About the same time is required to tie the leads. The actual time required to wind the coil on the shuttle and then pull it is very much less than that required to wind the same coil on a mould. Take for example a coil of 4 by 5 wires per coil, 4 by 1 in parallel. This means that the coil is four wires wide by five wires deep, and that there are four wires per coil in parallel, or in other words, that it is a five-turn coil. On a mould this coil would be wound in four sections of 1 by 5 wires per section. The time required for winding one of these sections is about five minutes, making a total of 20 minutes for winding the complete coil, since there are four sections per coil. The time required for assembling and tying these sections is seven minutes, giving a total of 27 minutes for winding the complete coil. With a puller, the coil will be wound on a shuttle with five turns of four wires, five minutes being required for this operation. The coil is then pulled and the leads tied in three minutes. This makes a total of eight minutes for the pulled coil against the 27 minutes required for the same coil on a mould.

The pulling machine is also adjustable for various sizes of coils. By simply loosening a few nuts and making a few adjustments the machine is ready for another job. No time is required for making a new tool and no space is required for storing the tool used on the last job. Within certain limits, fixed only by the size of the puller itself, its application is unlimited.

CONCLUSION

The cost of coils is reduced by the use of the puller, first, in the saving in time and material required for making the moulds and formers; second, in the cost of labor due to the fact that less time is required to make

the coils. Shorter delivery dates are possible because of the time saved in the development and manufacture of moulds and formers in addition to the time saved on the coils. The puller permits the use of shapes of conductors that are impractical on the moulds and formers. Soldered joints inside the coils may be avoided in many cases by the use of the pulling machine. Coils can be made by service stations without having to have moulds made up for their use, and in this way save much time and expense.

On the other hand, the former gives a more accurate coil, requiring a slightly shorter mean length of turn, thereby saving in copper. Irregular-shaped coils can be made on a former that would be impossible on the puller.

The mould must be used for one-coil-per-slot windings and for concentric windings. It is also used to an advantage for very small coils for small motors. It is generally advantageous to use a former or a puller for all other cases.

—*The Electric Journal.*

RUSSIAN PETROLEUM—EIGHT MONTHS OF 1916

CONTINUATION of the increased production of petroleum in the Russian Empire as a whole, in comparison with the production of 1915, is shown by the figures for the first eight months of 1916. The total output in this period was 407.5 millions poods, against 386.2 millions poods for the first two-thirds of 1915, an increase of 21.3 millions poods, or 5.5 per cent. This shows an advance over the 4.3 per cent. increase for the first six months of 1916 as compared with the production for the first six months of 1915. The output for July and August of this year was lower than that of either of the two preceding months.

The production of the whole Empire, by months, was as follows:

	1916 Millions of Poods	1915 Millions of Poods
January	47.7	50.2
February	44.2	44.5
March	49.6	51.9
April	49.8	47.9
May	58.7	49.4
June	53.7	47.4
July	51.5	48.9
August	52.3	46.0

The production of the separate fields of the Empire is shown below:

	First Eight Months	
	1916 Millions of Poods	1915 Millions of Poods
Four main fields of Baku	225.4	234.8
Surakhan	60.3	38.3
Binagady Wells	33.3	27.2
Cheleken Island	2.3	2.6
Sviatoy Island	4.6	4.5
Entire Baku group	325.9	307.4
Grozny	69.1	59.9
Ural (Emba)	9.8	11.5
Maikop	1.4	6.2
Fergana Province	1.3	1.2
Total for all Russia	407.5	386.2

The "Binagady Wells" in the preceding table actually include the wells of three groups of villages, Binagady, Kharasan, and Shubany. These wells are drained by hand labor, by the lowering of a bucket to the bottom of the well.

The production of the three village groups for the first eight months of 1916 and 1915 was:

	1916 Millions of Poods	1915 Millions of Poods
Binagady	22.0	17.8
Kharasan	6.5	4.9
Shubany	4.8	4.5
Total	33.3	27.2

Shipments of oil freights from Baku to all parts of the Empire during the first eight months of 1916 totalled 287.7 millions poods, against 281.2 millions poods in 1915. Of the 1916 shipments, 246.4 millions poods were to the Volga.

The following table gives total shipments from Baku, and shipments to the Volga alone, during the same periods:

	Total Shipments Volga Included		To the Volga Only	
	1916 Millions of Poods	1915 Millions of Poods	1916 Millions of Poods	1915 Millions of Poods
Crude oil	41.7	46.9	29.0	36.4
Oil residues (Mazut)	196.4	182.5	179.2	169.9
Kerosene	41.7	43.5	31.8	36.9
Other products	7.9	8.3	6.4	5.9
Totals	287.7	281.2	246.4	242.1

Stored oil and oil products of all kinds in the Baku industrial district on Sept. 1, 1916 totalled 67.5 millions poods, against 63.4 millions poods on the same date in 1915.

The stock of each product was as follows:

	1916 Millions of Poods	1915 Millions of Poods
Crude oil	32.2	27.7
Mazut (residue)	21.1	19.9
Kerosene	8.8	10.7
Other products	7.4	5.1
Totals	67.5	63.4

Refinery products at Baku totalled 228.1 millions poods for the first eight months of 1916, against 211.4 millions poods in the same period in 1915. The chief product was mazut (residue, used as fuel), the demand for which from the central regions of the Empire has been very strong. The production of kerosene and of lubricating oils shows a decrease, due to the absence of the former demand for them from Poland and the Baltic Provinces.

GOVERNMENT OIL FIELDS PROPOSED

Russian governmental development and operation of new oil fields in the Baku District has been proposed and planned in some detail by the Ministry of Commerce and Industry. The purpose of the project is

partly to make more secure the increasing supply of petroleum needed by the Government, and partly to secure some lowering of the prevailing high prices for all oil products. The plan, which has been approved by the Council of Ministers, contemplates the development of a total of 105 dessiatines of government oil lands on the Apsheron Peninsula,—45 dessiatines (121.5 acres) in the Sabunchani-Ramani region and 60 dessiatines (162 acres) in the Surakhan region. The machinery is to be operated by electric power. Production is estimated at approximately 50 million poods (about 4,740,000 barrels) a year. Cost of production is estimated at 24 to 26 copeks a pood, whereas the present market price ranges from 50 to 56 copeks. For development and production until the year 1922, the Ministry has asked a credit of Rs. 64,012,691 (\$32,968,535). —Russia.

PROGRESS OF AMERICAN SHIPBUILDING

STEEL merchant vessels building or under contract to be built in private American yards on December 1, 1916, according to builders' returns to the Bureau of Navigation, Department of Commerce, numbered 400 of 1,428,003 gross tons. On December 1, 1915, builders returns of construction or contracts for the construction of steel merchant vessels aggregated 202 vessels of 761,511 gross tons. The tonnage building or ordered on December 1, 1916, however, is less (17 vessels of 51,943 gross tons), than on November 1, 1916, the first break in the line of increases since the issue of these monthly returns began in February 1916.

During November, American yards finished 22 vessels of 68,922 gross tons which had been carried in these statements, and made new contracts for 7 steel merchant vessels of 18,285 gross tons.

During the current fiscal year the builders expect to launch 294 vessels of 904,231 gross tons, and during the fiscal year ending June 30, 1918, 106 vessels of 523,772 gross tons. These dates of launching, of course, are subject to the usual allowance for delays.

—*Marine Engineering.*

ORIGINATION VERSUS IMITATION IN DESIGN

By R. H. M.

THE writer received his first instruction in mechanical drawing from a man employed as designer by a large manufacturer. This teacher's answer to the question as to how a person could most easily become a successful designer was, "Imitate other designs." The thought of being obliged to become an imitator was quite disappointing, so he secretly resolved not to follow this counsel. Later, when attending a technical college, the writer thought that when he entered upon commercial work he would be able, using the fundamental principles, to develop with great freedom new mechanisms for any desired end. During nine or ten years of practical ex-

perience, however, he has had cause to modify some of his early views.

Given the task of designing a machine to accomplish a certain result, an early reluctance to study and imitate known designs of that class of machines was partly due to a desire to accomplish the same result by means not used before because of the personal satisfaction which comes from originating. It was also due to a sort of sentimental disinclination to wilfully copy the work of others as closely as is legally allowable. This attitude was perhaps rather inconsistent in view of the fact that everything learned up to that time was the result of others' work—all by instruction or from books; nothing by original investigation in new fields. But he had pictured the work of the mechanical engineer to be, for the most part, that of an inventor, and thought that to study and try to remember the maximum possible number of mechanisms used in various fields would operate against the cultivation of the inventive instinct.

Because of such opinions the writer failed to study books and current technical literature at the time when a man is perhaps best fitted to get the most out of reading with the least expenditure of energy—that is, when just out of school, for he has then a more intimate knowledge of mathematics than he will ever have again. A great many engineering graduates make the same mistake by thinking they are through with books and assuming that their main advancement thenceforth will come automatically from practical experience. But just at this time a varied reading of technical literature, properly chosen, can greatly increase a person's rate of advancement; for it is largely the lack of knowledge of minute details of design and manufacture which causes men fresh from school to be considered inexperienced. For this reason, technical schools should use text-books which are thoroughly up-to-date, so that the student may be drilled in the fact that he is studying not only principles, but their embodiment in examples of the best practice down to the smallest details.

One learns in a technical school the fundamental principles of chemistry, physics, mechanics, mathematics, and drawing, but becomes acquainted in a comparatively small degree with the practical application of these sciences to machine parts. When later the graduate is required to design a machine to accomplish a certain result, he must, if working independently, choose between the alternatives of using only his knowledge of basic principles and the few machine elements with which he is acquainted as the basis for design, or of finding out what others have done in some similar machine.

Theoretically, perhaps, the fewer machine details with which the inexperienced man is familiar, the wider opportunity there is for developing his resourcefulness in design. But when a person enters commercial work, the cultivation of his ingenuity must be incidental to his main activities. It takes more time and money to develop devices when one starts with a knowledge of a comparatively few simple mechanical forms, so that financial considera-

tions demand that one learn as many as possible of the details which are applicable to the work at hand. The shapes of apparently minor machine details are determined by principles discovered in actual manufacture and operation. If a man does not know the approved forms of the details of the machine he is designing, he probably knows only a few of the principles involved. Certain forms come to be looked upon as good practice in a certain line, and if these are adhered to the machine is easier to sell than one which contains something strikingly original, but the successful operation of which will possibly be doubted.

Even if one thinks his design for a new machine to be largely original, he seldom compounds it out of purely single elements, but is usually unconsciously making many adaptations from combinations he has seen, however limited his knowledge may be. He gains no more credit for being an unintentional imitator than for being a conscious imitator. He may have given good training to his inventive faculties by working out a few entirely new mechanisms, but the result of his work will probably not be so successful as if he had incorporated as many previously proved combinations as were possible mechanically and legally. It is certainly unwise for the man just out of school to draw mainly upon what he has learned there and upon his imagination for his designs. From the basic mechanisms given in his text-books he can, perhaps, reason correctly concerning the operation of modifications, but he can make a great gain in efficiency if he stores his mind with all the designs he can observe in practice and technical literature.

There are comparatively few positions that offer to the designer the opportunity to use or develop his inventive faculties in sufficient degree to attain maximum advancement through knowledge gained during his work alone. About all most positions offer is an opportunity for one to use and cultivate an ingenuity for adaptation from known designs in his own or other fields. This requires observation and absorption to qualify one as a designer more than it does the ability to originate. A knowledge of the details of construction of a wide variety of machines will enable a person to adapt parts of them to other purposes, to modify them to suit special conditions, or to duplicate them if required, even if the designer has not come into contact with them. He can do this in much less time than when he knows only the fundamental principles of mechanics, in relation to the machine he is called upon to design, and is obliged to rely upon his inventive faculties for working out the details. Employers advertise for men experienced in a certain line far more often than they advertise for men capable of originating new devices. Before one is asked what can be developed for a certain purpose, he is asked what others have done. The more ideas of actual tested mechanisms a man can bring the better the employer likes it. Even an able designer, acquainted only with the general appearance of a lathe and unfamiliar with the details of construction, who should attempt to design one without first making a

study of the machine, would undoubtedly produce the same comparatively inferior tool as the early designers.

The writer thought that the ability to originate was the most necessary qualification for success in the engineering world; but now believes that, in most positions, a qualification which is of more value to one's employer, and consequently more lucrative to oneself, is having such an intimate knowledge of machine construction in many fields that it is rarely necessary to originate. If a designer can modify and adapt to his needs some combination of elements previously used and known to have worked successfully, he has made a commercial gain, even if he has not made as great a scientific gain as if he had spent more time and money in evolving a new combination of elements. Also, if a designer is not familiar with the ground already covered in his field, he will probably retrace the steps of others and believe the combination he is developing is new. It should be possible, when one is thoroughly acquainted with a certain line of industry, to avoid the tendency to duplicate designs which he knows, if it be necessary. But he is more likely to avoid duplication than the man who knows nothing of the field, however prolific the latter may be of ideas which he thinks have been unused. Where there is one position in which the ability to originate new forms or mechanical combinations is the prime requisite, there are possibly one hundred draughtsmen's or engineers' positions demanding a knowledge of the employer's product, acquaintance with the design of some machine which he wishes to build, and experience in production, erecting or operation. Therefore much of a designer's training should consist in becoming acquainted with machinery used in all fields, in order to modify and adapt known combinations to the work in hand.

—Machinery.

REMOVING COENTIES REEF FROM THE EAST RIVER, NEW YORK HARBOR

By EDWARD H. DION

COENTIES REEF, which is the name of a rock ledge about 600 ft. off the outer end of Pier 6, East River, in the Borough of Manhattan, is now in the course of removal. The United States Government appropriated sufficient money to take out material to a depth of 35 ft. below mean low water, and the City of New York has appropriated another amount, so as to increase this depth 5 ft. thus giving a 40-ft. unobstructed channel here, the adjoining waters already having this depth.

This reef is 600 ft. long and 300 ft. wide at its outermost points. The Government borings show a depth of from 25 to 32 ft. below mean low water. As none of the blasted area has been dredged, the rock formation is unknown; but it is probably gneiss. It has a covering of mud and sand on the deep area and clean rock on the shallow portion, due to scouring by the strong tides. Part of this reef was removed in 1875, to a depth of 25 ft., but broken rock left over from this job is occasionally struck.

Two of the subway tubes leading from Whitehall St., Manhattan, to Montague St., Brooklyn, now under construction, pass through this ledge. The top of the head- ing is at an elevation of 64 ft. below mean low water, and blasting is going on at the present time at a point directly underneath the drill boat used by the contractor. The blasting and drilling are heard by the tunnel workers, and a very distinct shock is felt on board the drill boat when tunnel blasting is done.

The current has a velocity of from $4\frac{1}{2}$ to 5 mi. per hr., and there is a tidal range of about 5.5 ft. This strong current necessitates a very secure anchorage and a close watch of the boat spuds. Moves, after the completion of a row of holes, are often delayed until slack water, because of the fear of being carried away. Traffic at this point is very heavy; consequently, the Secretary of War has restricted a buoyed area, to safeguard against accident due to the upheaval of rock, broken drill bars that project above this rock, and to protect the contractor's floating plants.

Work was started on June 9, 1916, and at the present time about three-eighths of the area has been blasted. One 5-drill frame machine is being used, operations being carried on in three 8-hr. shifts. The drill machines are Ingersoll-Rand, rock, subaqueous, known as H-64 and K-64 types. The drill bars are 55 ft. long, made up of soft-steel stock and tool-steel bits. Drilling is done to an overdepth of 5 ft.—that is, to a 45-ft. plane below mean low water. From experience derived on former rock work, this depth is thought to be sufficient to acquire the desired dredging depth to grade.

The longitudinal center line of the reef runs in a north and south line, and it was at first proposed to move the drill boat 5 ft. along this line each time, and then the entire reef would be covered in two cuts. As the current takes a sweep at this point, striking the boat broadside, the floating debris caused a lot of trouble to the drills. The force with which some timbers hit them was sufficient to cause bad bends and consequently much lost time in changing bars. Difficulty was also experienced in making moves after a row of holes had been completed, due to the water piling up on either side, depending on ebb or flood tides. After a couple of weeks' trial the position was changed to a move diagonally across, thus bringing the current on the head ends. This method has been used since with success.

In order to reduce drill-bar troubles, cast-iron pipes of decreasing diameters were attached together by steel bands forming a collapsible pipe, which can be raised when moving the boat. A cross-pipe is fitted at the lower end, to permit the drillings to wash out. The pipe is suspended from the drill frame by steel leaders, and is known as a sand pipe. Bent bars have been practically eliminated by this scheme.

After a move, the location of the drill boat is determined by shore ranges, which consist of targets and points on prominent buildings. The plotted locations have been checked by transit intersections, and the error rarely

exceeds 2 ft. The sand pipes are next lowered, until they rest on the bottom.

The drill bars passing through the sand pipe are started and driven to rock. The elevation is noted, and drilling continued to the 45-ft. plane. The drill is then pulled out and lowered again, this operation being repeated until the hole is clean. A charger pipe suspended from the drill frame is then lowered to the deck, where the blasters insert the dynamite. This pipe has a slit along the side, the sticks of dynamite are put in from the bottom, the last two containing the exploders. The wires are held on deck while the pipe is lowered in the sand pipe. Rammers tamp the charge to the bottom of the drilled hole, and the charger pipe is then raised. The charges are set off by machine. One hole is fired at a time, and the boat is not moved away from its position, the surface water being hardly disturbed.

Each drill frame has four holes on each move, and is capable of an overlap of one hole on either side. As the rock is very hard and subway operations demand caution, heavy charges cannot be used; therefore holes are drilled on 5x6.3-ft. spacings. This permits 20 holes to be drilled per move. The time required to drill holes varies greatly, shallow ones often taking longer than the deepest ones. Seams are frequently struck, causing sticking, which is one of the greatest troubles encountered. Holes after completion sometimes refill with sand or with pieces of broken rock and are very troublesome to clean. From all indications, including the examination of a diver, the rock is well shattered.

The number of feet drilled by night shifts bears a very good comparison to the day work; and as the only additional cost to running the plant is lighting, an even distribution of cost of operation for 24 hr. is regarded as just.

—*Engineering News.*

WATER FOR STEAM BOILERS—ITS SIGNIFICANCE AND TREATMENT

By ARTHUR C. SCOTT, DALLAS, AND J. R. BAILEY, AUSTIN, TEXAS.*

IN recent years the value of a critical analysis of production costs and operating efficiencies has become prominent in the business of manufacturing, and since water is necessary for the operation of nearly every industrial establishment, its quality is receiving more attention than formerly. The plant owner is rapidly modifying his views heretofore concerned only with the available quantity, because of the important factor in the operating cost due to the use of water unsuited to the service required. This is especially significant in steam making. Water from lakes or large reservoirs is ordinarily most satisfactory for boilers, since it is chiefly rain water and surface drainage, and the suspended matter has had opportunity to settle. Under conditions of a long drought, however, as the reservoir capacity is reduced, the organic matter from algal growth and other sources may have an appreciable

* Abstract of paper presented before American Society of Mechanical Engineers, New York, December, 1916.

effect upon the quality of the water. River water is more or less variable in character, depending upon the location and extent of the watershed or drainage basin and upon the rainfall. Slow-moving rivers may carry a large amount of mud, some of which settles out readily, while the red or yellow mud will generally remain in suspension a long time unless some coagulant like sulphate of alumina is used. A river frequently picks up considerable organic matter, which by decomposition forms organic acids that corrode boiler metal. The character of the drainage area of a river will affect the character and content of dissolved mineral matter in the water, and this will vary more or less with the season of the year and may vary from day to day part of the time. Well water varies in quality with the location and depth of well and with the rainfall. Water from deep-well sources is usually low in organic matter but contains mineral constituents dissolved by the water in passing through the earth.

Boiler Failures and Losses Due to Scale

Reports show an increased number of dangerous defects in boilers from year to year due to scale, corrosion, priming, etc. Aside from the dangerous condition of a "scaly" boiler, scale also means fuel waste, ranging according to the thickness from 2 per cent. for $\frac{1}{64}$ in. thickness, to 90 per cent. for $\frac{3}{4}$ in. as a general average. Other troubles through scale are clogged feed pipes and water- and steam-gauge connections, and valves prevented from completely closing.

Water-Softening Processes

The common methods of reducing scale troubles are: (a) Two types of cold processes for the actual softening of water; the intermittent originating with Clark in 1841 and the continuous invented about 1867; (b) the hot process; (c) live-steam purifiers (d) boiler compounds. For very large plants where several hundred thousand gallons per day are used, a considerable expenditure is justified for tanks and mechanical equipment for the cold process and purification, which is fundamentally a treatment of the water with proper amounts of milk of lime and soda ash. These cold processes perform their chief service in softening water for locomotives and in large plants where water is used in considerable quantities in connection with jet or barometric condensers, or where it must be softened for other purposes than boiler feed alone. The hot process is particularly desirable for plants where exhaust steam is available. Purification of the water is partly obtained by heating to the approximate boiling point, but sufficient soda ash is added to satisfy the alkaline earth sulphates and chlorides and any acid present. The essentials are heat and soda, and the whole scheme is virtually embraced in the ordinary operation of an open-type feed-water heater, with the introduction of soda ash into the hot water. Live-steam purifiers are useful as partial purifiers, but are always subject to boiler pressure, waste some heat, must be placed higher than the boiler level, and frequently give trouble from water hammer. Boiler compounds are more or less palliative in

their action and produce results by (a) acting as chemical reagents combining with the scale-forming impurities, breaking them up and precipitating them as sludge; (b) acting mechanically on the precipitated scale-forming matter and entrapping it as it is precipitated from solution before it has formed a hard, adherent scale. Example of materials in use under (a) are soda ash, caustic soda, trisodium phosphate, sodium fluoride, and compounds of tannin; and under (b) gelatinous or starchy materials, such as ground bones, hoofs, horns, slippery elm, and potatoes. Boiler compounds are to be recommended for use only in small plants whose capacity will hardly justify arrangements to purify the water before it enters the boiler. The steam boiler should be used primarily for generating and storing steam energy, not as a precipitating tank. If it must be used partly as the latter, it is most economical to have the feed water analyzed, and the character and amount of chemical reagents determined to effect the necessary purification. These reagents of definite strength and known amount, properly proportioned for the conditions, should be pumped in with the feed water as it passes into the boiler.

Blowing Off Boilers

The main factors in ordinary boiler-water purification are heat, soda ash and blowing off, with possible filtration when this can be arranged, as is sometimes done with the hot process. The blowing off is important. It should be done under low pressure to be effective in carrying out the sludge and to reduce the boiler stresses coincident with rapid blowing under high pressure. If it must be done under high pressure, the valves should only be "cracked"; otherwise only a small part of the sediment will be carried out, because the vortex or whirlpool formed draws down clear water, leaving the main body of the sludge intact. Undoubtedly some of the troubles recorded as due to scale-forming water are really attributable to the disregard of proper methods of blowing off, and to the pumping in of cold water, thereby overstraining the boiler material.

Boiler Troubles Caused by Corrosion

The trouble due to corrosion of sheets, tubes, stays, etc., is in some cases more acute than ever occurs with scale. Carbonic acid gas, occluded oxygen, and sodium and magnesium chlorides are the most frequent offenders, and the chlorides are so difficult to remove that the cost is practically prohibitive. Corrosion due to the chloride ingredients is particularly destructive to steel boiler tubes, hot-water piping, and brass-seated valves. Galvanized steel pipe is not immune, because any defect in the zinc coating permits local galvanic action, with consequent rapid destruction of the zinc coating. Water with as much as 500 parts to a million of these chlorides, especially when hot, is destructive to steel pipe and fittings. Waters are frequently both scale-forming and corrosive; usually a water having a corrosive tendency will be more or less scale-forming. Caustic or carbonate alkalines or caustic lime act as neutralizing agents for corrosive in-

gredients, but must be carefully handled or the scale-forming matter will be increased. Their use should be confined to treatment of the water outside the boiler, if possible.

Boiler Troubles Due to Foaming or Priming

Boiler troubles due to foaming or priming apparently depend largely upon the concentration of alkali salts in the water, although silt, organic matter, loosened scale, lubricating oil, character of load and design of boiler all have an appreciable bearing upon this phenomenon. Surface blowing is a remedy where it can be applied, and usually the proper use of the main blow-off will reduce the concentration of salts in the boiler. There are many natural waters of sufficient alkali content to produce immediate foaming whenever the pressure at the surface of the water in the boiler is relieved by the sudden and large use of steam. As there is no chemical treatment that will precipitate alkalies from solution, such waters are to be rejected for boiler use.

Hardness in Water and Its Reduction

The combined bicarbonates of magnesium and calcium constitute temporary hardness, while the other salts of magnesium and calcium constitute permanent hardness. Temporary hardness can always be expected in river, spring, and well waters, but a great many waters do not possess permanent hardness. Waters with less than 8 grains per gallon of scale-forming material are considered very good; 8 to 15 grains good; 15 to 20 fair; 20 to 30 poor; 30 to 40 bad, and over 40 very bad. Scale due principally to temporary hardness will deposit as a loose sludge, readily blown off. Where the ratio of permanent to temporary hardness exceeds 1 to 4, the scale will be hard, cement-like, and very adhesive to boiler metal. Water treatment, or softening, removes the greater part of the calcium and magnesium. The bicarbonates are removed practically altogether, but of the sulphates and chlorides the calcium and magnesium are removed and the SO_4 and Cl left in the water. As an equilibrium must exist between the basic and acid ions, other basic ions must be substituted by adding soda ash. When water is softened outside the boiler and the sludge removed by sedimentation and filtration before the water enters the feed-water heater, the chemicals used in the treatment are either lime alone, or lime and soda ash. If the lime and magnesium are present as temporary hardness alone, that is, as bicarbonates with the sulphates of these bases absent, lime suffices for the chemical treatment. If either the magnesium or both the magnesium and calcium are present in other salts, the lime treatment must be supplemented by soda-ash treatment.

Corrosion and Foaming

Pitting and corrosion in boilers are frequently due to magnesium and chloride and less often to calcium chloride. Either of these salts is very pernicious in that on hydrolysis it produces free hydrochloric acid. This action is, however, in large measure counteracted when the temporary hardness runs high. Waters high in nitrates are

always highly corrosive. Large amounts of sodium chloride also tend to make waters corrosive. Some waters very low in mineral content produce corrosion, especially at the feed-water intake, owing to a large amount of dissolved oxygen and free carbonic acid. Peaty waters are harmful to boilers by reason of the vegetable acids which they contain. Waters containing a free mineral acid are particularly harmful. Waters which contain large amounts of alkali salts, especially sodium carbonate and sodium chloride, have a tendency to foam. Waters low in mineral content but high in organic matter, though perfectly clear, may also be troublesome. From what has been said relative to the effect of large amounts of alkali salts on waters, it is evident that one good result to be obtained from chemical control in water softening is the prevention of an overfeed of soda ash, as any large excess of this chemical will produce a foaming water. The only methods of combating foaming waters appear to lie in frequent blowing off and washing out the boilers, and along lines of improved boiler construction.

—*Fire and Water Engineering.*

FEDERAL SHIPPING BOARD

ANNOUNCEMENT of the following nominees for the new Federal Shipping Board was made by President Wilson on December 22: William Denman, San Francisco, Cal., for a term of six years; Bernard N. Baker, Baltimore, Md., for a term of five years; John A. Donald, New York, for a term of four years; James B. White, Kansas City, Mo., for a term of three years, and Theodore Brent, New Orleans, La., for a term of two years. These names have been sent to the Senate for its approval and as soon as ratified it is expected that the new board will make its headquarters in the port of New York.

As this is the first Board of its kind which has been established in the United States with powers for building up and regulating American shipping in the world's trade, it should receive the earnest support and coöperation of all shipping interests. Ample opportunity will be given to the Board to test its authority, and upon its success will rest, in a large measure, the future development of the American merchant marine.

AMERICAN MACHINERY IN RUSSIA

IN a recent issue of *Russia*, a monthly journal of Russian-American trade, attention is called to the fact that an important reason for Germany's predominance in the machinery trade in Russia is the speed with which the defective parts could be replaced. As against days for filling such orders in Germany a good many weeks are required where they are sent to the United States. It is pointed out that American manufacturers will be obliged to stock Russian warehouses with spare parts and equip repair shops for instant service. In addition, American firms must sell direct and not through German middlemen.

—*The Iron Age.*

STANDARDIZATION OF CARGO BOATS AND ENGINES

The shortage of cargo-carrying vessels is leading to some interesting proposals which have for their object to secure rapidity of output and minimum cost of production by standardization of design and manufacture of both hulls and engines. In connection with the hulls one of the proposals is that steel works themselves should develop a standardized system of supplying dimension materials, shaped and punched ready for assembling in a standard ship of specific dimensions.

In the matter of engines a definite step has been taken by the North-East Coast Institution of Engineers and Shipbuilders in a proposal recommending a standardized design to be manufactured on lines that will enable specific details to be produced in bulk at a cost quite impossible by methods now prevailing. For example, one firm of builders might be called upon to manufacture, say, engine fittings and the like for several other firms. The council have further called upon a committee of members to pre-

pare a guidance specification for cargo boat engines, which specification will be submitted to and discussed by members themselves.

The members will, therefore, collaborate in the production of the specification, and, as the membership includes all the builders on the coast, together with a large number of highly experienced superintendents and consultants, all of whom will unquestionably give of their best, the ultimate specification may be accepted in advance as representing the highest state of the art now available.

Each issue of the specification will hold good for one year only, and at the end of each year the members in general meeting will be invited to collaborate in bringing it up to date. Engine builders and shipowners will therefore be able continuously to avail themselves of the collective experience of this highly progressive body of engineers. If success attends this departure on the part of the institution, the ultimate effect on output, cost, and efficiency cannot fail to be very great.

—*Machinery.*

FOREIGN NOTES

THE MYSTERY OF METALS

THE biologist, the chemist, the surgeon has each no doubt his own decisive opinions as to the utterly fundamental basis of our modern civilisation. The first may hold it to be man's superlative power of adapting himself to his environment. The second probably would insist that it is to be found in man's power of transforming Nature's raw materials into food and other products essential to our modern manner of life. The third perhaps may tell us that he finds it in man's power of being able to cure his own diseases. The engineer, if appealed to in the matter, can only answer that these opinions are wrong, and that in the strength with which Nature has endowed certain of her materials, and in man's ability to make use of such strength, is to be found the real master key to every aspect of civilised life, as we know it to-day. No engineer, it is believed, can reflect seriously on the matter without arriving at this conclusion. Is it not therefore truly amazing to find that, in spite of the vast edifice which has been raised on the possession of strength by a few natural materials, the engineer is utterly ignorant even to-day as to the cause of strength in the metals, woods, and stones which he uses? He knows with fair accuracy how much strength each

possesses, and to a certain extent he knows how the amount of his strength is affected by variations in the treatment he may accord to the material exhibiting it. But as to why it should possess any strength at all, why the strength of one material should be different from that of another, why it should be different in two samples of the same material treated differently, he knows not at all. We do not pretend to be able to instruct him in the matter. For the present we only propose to discuss some of the difficulties which lie in the way of any who attempt to investigate the cause of strength in metals and other materials employed by the engineer.

Let it be noted at once that recognised authorities on the strength of materials never discuss why materials possess strength. At most they will merely make some very brief and highly nebulous reference to intermolecular forces. Yet, if we accept the molecular theory of matter, it is to the existence of intermolecular force that we must, in the end, attribute the strength of metals. What is the nature of such intermolecular forces in the case of solid bodies? That it is an attraction, and that it follows the inverse square law of gravitational attraction would appear, at first sight, too reasonable an assumption to require any justification. Justification, however, is to be found in

the fact that the phenomena of surface tension and capillarity in liquids can be very satisfactorily explained on the assumption that the intermolecular force follows this self-same law. The inverse square law of attraction is, we know, true for planetary masses at planetary distances apart. It appears to be true for molecular masses at molecular distances apart in the case of liquids. Why should there be any doubt as to its truth in the case of the molecules of solids? There are two simple answers to this. First, the force between two bodies attracted in accordance with this law falls off rapidly as the distance between them is increased. Hence, the more a specimen of metal is strained under tension the less should become the force necessary to maintain the strain. The exact opposite is, of course, the fact. Secondly, assuming that this difficulty can be overcome, and that we can account satisfactorily for the possession in a metal of tensile strength on the supposition that the intermolecular force is an attraction, how are we to explain, in keeping with this assumption, the possession in the same metal of compressive strength? As an indication of the state of opinion in this matter let us quote the words of one of our greatest authorities on the molecular structure of matter. In his book "The Dynamical Theory of Gases," Mr. J. H. Jean writes:—"The fact that a solid body resists both compression and dilatation indicates that the force between molecules changes from one of repulsion at small distances to one of attraction at greater distances." There he allows the subject to rest, for his work is with gases and not with solids. But if we try to follow up this hint we find ourselves in difficulties at least as great as that which, to overcome, the suggestion of a change in the law is made. Thus we are forced to contemplate either a sudden change in the law or a gradual one in which the intermolecular force as the distance between the molecules decreases changes from an attraction, vanishes altogether and then becomes a repulsion. The supposition that the change is instantaneous is to our minds, too "anti-physical," as Claude would say, to merit discussion. The alternative supposition would leave us to seek a state of affairs no evidence as to the existence of which has yet been noted, namely, that somewhere between being in a state of tension and a state of compression a specimen of metal should pass through a state in which the cohesion between some or all of its molecules entirely disappears. Is it conceivable that the molecules near the lower face of a loaded beam attract one another, and that those near the upper face repel one another, and those on the neutral axis exert neither attraction nor repulsion on one another? Is this state of affairs compatible with the fact that the maximum shearing force is developed at the neutral axis, and has to be met by the action of those molecules which are out of action as regards resistance to tension and compression?

We see, then, that difficulties arise if we attempt to explain the strength of metals on the supposition that the inverse square law of attraction holds good between the

molecules. We see, too, that, by supposing the intermolecular force to change from an attraction to a repulsion, according as the applied load changes from tension to compression, we merely raise fresh difficulties at least as great as those met with under the first supposition. Before adopting the second supposition—which, be it noted, does a certain amount of violence to other theories connected with the properties of matter—we ought to satisfy ourselves that the objections to the first are really such as to rule it out of consideration. Is it, as it is stated to be, truly incompatible with the possession in a metal of elastic strength both in tension and compression? We by no means feel convinced that it is. From a study of crystallography it appears certain that we are not justified in thinking of the molecules of a solid body as arranged simply at random, or even like a pile of round shot. We may reasonably suppose that they are grouped round the periphery or surface of some geometrical figure, such as a circle or a sphere. The elastic properties of a ring or sphere of attracting molecules are essentially different from those possessed or exhibited by the same molecules arranged like a pile of shot. The ring or sphere, for instance, can be deformed without separation of the contacting molecules, so that the force necessary to maintain the deformation does not essentially fall off as the deformation is increased. It is not difficult to prove that a ring of six attracting molecules is in unstable equilibrium, and that any attempt to elongate or compress it will cause it to collapse of its own accord. Nevertheless, it is conceivable that, with higher numbers of molecules in the ring, a condition may be reached in which the ring, simply by the attraction between the molecules forming it, may be capable of resisting elastically both tension and compression. We make these remarks only to show that it is by no means easy to prove that the abandonment of gravitational attraction is necessary in order to explain the strength of metals. We do not for a moment suggest that this molecular ring theory is even a promising field for investigation. It should be noted that it regards the molecules as being at rest. Are we justified in neglecting the motion with which, according to the kinetic theory of heat, they are endowed? Remembering the well established effect of temperature upon the strength of metals we fear to answer that we are.

We are thus in this matter led from supposition to supposition until the accumulation of hypotheses becomes formidable. Let us therefore recall the words of one who himself devoted long years to the study of molecular physics. "If," said Clerk Maxwell, "we frame an hypothesis that the configuration, motion or action of a material system is of a certain definite kind, and if the results of this hypothesis agree with the phenomena investigated, then, unless we can prove that no other hypothesis would account for the phenomena, we must still admit the possibility of our hypothesis being a wrong one."

—*The Engineer.*



Philadelphia Association of Members of the American Society of Civil Engineers

SAMUEL T. WAGNER, President

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THE Philadelphia Association of Members of the American Society Civil Engineers, through the efforts of Mr. Richard L. Humphrey and President Samuel T. Wagner, was most fortunate in obtaining the consent of Dr. Arthur L. Day to address the Society. The subject was one of such unusual interest that the Board of Directors called a special meeting of the Society to hear Dr. Day speak.

Dr. Day is Director of the Geophysical Laboratory, Carnegie Institution, Washington, D. C., a scholar of international reputation, and has performed a vast amount of

research work in connection with active physical exploration. He stands foremost in the ranks of scientists who have made a study of volcanoes, and the Society and its friends had the rare opportunity, on Tuesday, January 30, to hear Dr. Day speak upon that mysterious giant of the Sandwich Islands, "Kilauea," whose recent activities have been so startling.

Dr. Day had a series of remarkable "close-up" pictures of volcanic activity which he showed and explained in that very delightful manner that the Doctor possesses.

Industrial Notes

PAUL R. KETZER, formerly Eastern Manager for the Metalwood Manufacturing Company, wishes to call the attention of his friends and associates, also manufacturers to whom he is known, that he has gone in business for himself, or in other words is one of a cluster of four live wires, all of them being known throughout this City. The name of the company is the Ketzer Machinery Company, handling power, steam, hydraulic, special machinery and tools, with offices located in the Bourse Building, Exhibition Department, Philadelphia, Pa.

ALAN WOOD PLANS NEW BLAST FURNACE

WE note with interest that The Alan Wood Iron & Steel Company, Philadelphia, is having plans prepared by Julian Kennedy, Pittsburgh, for a new blast furnace at Swedeland, Pa., which, when erected, will give the company three at that point. Its two furnaces now in operation have an annual capacity of 275,000 tons. Whether the new furnace will be constructed as an independent unit or be operated as an alternate stack in connection with those already built, is not yet fully determined. Without the new furnace the company might encounter a shortage of iron after the completion of three open-hearth furnaces which are now being constructed at Ivy Rock, which is just across the Schuylkill River from the furnaces. The company is also installing an ore-handling plant which will be equipped with a crane of sufficient power to pick up a loaded freight car and empty it. Other improvements call for a number of workmen's dwellings.

Preliminary work for laying the first keel at the new plant of the Sun Shipbuilding Company, Chester,

Pa., is expected to get under way this week. A large number of workmen are finishing the five ways and the cranes are being completed. The machinery has been installed in the fabricating plant. The building for the administration department is now being erected and the steel columns for the boiler shop are being put in place. This later building will be 120 x 400 ft.

—The Iron Age.

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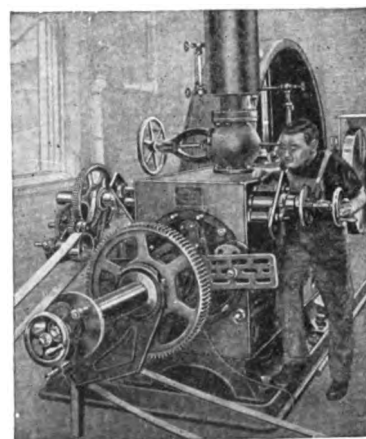
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CONTENTS OF THIS ISSUE

	PAGE		PAGE
Officers, Directors, Standing and Special Committees of Engineers' Club.....	112	Chemical Research in Philadelphia	129
Editorial.....	113	By DR. EDGAR FAHS SMITH Provost, University of Pennsylvania	
Fortieth Anniversary of Engineers Club of Philadelphia.....	114	Initiation of Explosions.....	135
Committee on Papers.....	115	By WALTER ARTHUR	
Announcement by LEWIS H. KENNEY, Chairman		Positions Vacant.....	139
Secretary's Notices.....	116	American Society of Mechanical Engineers.....	140
Business Meeting of The Club, Feb. 20, 1917		Illuminating Engineering Society.....	141
Regular Meeting Board of Directors, Feb. 13, 1917		American Society of Civil Engineers.....	143
Special Meeting of The Club, Jan. 26, 1917		American Society of Heating and Ventilating Engi- neers.....	145
Committee on Membership.....	119	American Institute of Electrical Engineers.....	146
Candidates for Membership		The Commercial Field for the Engineer.....	147
As We Pause by the Wayside.....	120	By GEORGE P. BALDWIN District Manager of General Electric Company	
By S. M. SWAAB		Society of Automobile Engineers.....	149
Welfare Work.....	121	Technology Club of Philadelphia.....	150
By J. CACCAVAJO		Mobilizing Our Industrial Resources.....	151
Professional Directory.....	128		

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MANTON E. HIBBS
J. B. McCORD
CHAS. H. FROMMER
WM. H. BOARDMAN

PUBLICITY

S. M. SWAAB, Chairman
J. H. M. ANDREWS
W. P. TAYLOR
JOS. A. STEINMETZ
LEWIS H. KENNEY

TELLERS

G. E. CROFOOT, Chairman
JOHN P. MUDD
HAROLD GOODWIN, JR.

ALTERNATE TELLERS

CHARLES PENROSE, Chairman
JOHN S. ELY
CHAS. F. PUFF, JR.

SECRETARY TO THE SECRETARY

S. M. SNEDEKER

Editorial

DURING the year 1877, a number of Philadelphia Engineers who had been meeting informally at each other's homes decided to form an organization for the reading and discussion of professional papers and social intercourse. The plan thus formed was subsequently developed into the organization known as the Engineers' Club of Philadelphia, and was duly chartered as such on December 17, 1877, and later, on January 9, 1892, was incorporated in order to better meet the needs of its members. Our membership increased from but 25 in 1877 to about 700 in 1907.

From time to time new quarters were obtained to accommodate the growing organization, and the last change of location was made in January, 1908, when the present Club House was occupied, and provided an auditorium, a library, restaurant facilities, and accommodations for permanent and transient use adequate to the requirements of that time.

But the spirit of progress was not dulled by these advancements, and in 1913 the next important step was taken in the movement which permitted technical and engineering societies and organizations in Philadelphia, whose objects and activities are such that they could co-operate with the Engineers' Club, to become affiliated with the Club, but at the same time preserve their separate identities. At present seven such organizations are affiliated with the Club, and others of the few remaining societies eligible have indicated a desire for affiliation in the near future.

How well the underlying thought of the affiliation movement for affording better opportunities for the members of the different branches of our profession to join in a co-operative movement for the advancement of engineering has been realized is best and briefly told by the story of the increase of membership campaign, when, in four days of November, 1915, over 1800 members were added to our membership, which now numbers nearly 2400 and is steadily growing.

The Board of Directors has carefully considered the potential force of this body of members and for the purpose of permitting its wider development has presented the revision of the By-laws now under consideration, which, if adopted, will enable the Club to fairly meet the present conditions and carry still further toward the development of the Club:

In its technical work,
In its social features,
In an enlarged Club House;

and that the Club will realize its aims and desires in these matters and maintain its prestige, we have no doubt.

THE organization of the Society of Terminal Engineers, notice of which is given in the columns of this issue, brings into the field of organized endeavor a society whose purpose is to give scientific consideration to the designing of properly balanced and properly equipped terminals for transportation facilities.

The original use of the striking simile that water can only pass out of a bottle as fast as the size of the neck of the bottle will permit is accredited to the late James J. Hill, to call attention to the situation of the railroad and steamship business of this country, the various radiating lines of which may be compared to the body of the bottle and the terminals to its neck. He realized, probably earlier than most transportation experts, that the future of quick and economical freight transportation depends more upon the improvement of our terminal facilities than any other one element of the equation.

It is a well-known fact that terminal costs consume practically all but a minor and almost negligible proportion of the total tariff receipts of our transportation com-

panies, and that the aggravated and costly instances of car famines, which are becoming more and more common every year, are due, not to a failure of the carriers, either land or marine, to move goods with reasonable rapidity while in actual transit, but to the utter inability of the present terminal equipments to expeditiously handle goods after they are delivered to them from the ships or cars.

Whether terminal delays and the high costs at terminals are due to lack of proper trackage—although at present there is one-third as much trackage devoted to terminal and switching uses as there is to actual transportation use—or to lack of proper mechanical equipment for the rapid handling of freight at the terminals, or to inefficiencies of operation which closer study and more intelligent organization can eliminate, is a question which remains to be solved, and the new society proposes to address itself to this "terminal problem" by special and exhaustive study of the whole situation.

FORTIETH ANNIVERSARY of the ENGINEERS' CLUB OF PHILADELPHIA

THE Banquet Committee takes pleasure in announcing that arrangements have been made to hold a banquet on March 30th at the Bellevue-Stratford in honor of the fortieth anniversary of the founding of the Club. The subscription will be \$4.00 per plate.

No gathering of such a character has been held by the Club in the last ten years, and it seems that this fortieth anniversary is a peculiarly happy time at which to hold a dinner. The Committee has arranged for a brilliant program of speakers, and hopes that the banquet will be so successful that it will be repeated annually.

The Club Development Committee has been carefully considering the extension of Club facilities and will present definite plans for the development of the Club.

The Board of Directors desires each member to be present at this birthday party, because announcements will be made which will have an important bearing upon the future of the Club. The formal invitation to attend this dinner will be sent you within a few days.

THE BANQUET COMMITTEE.

Engineers' Club of Philadelphia

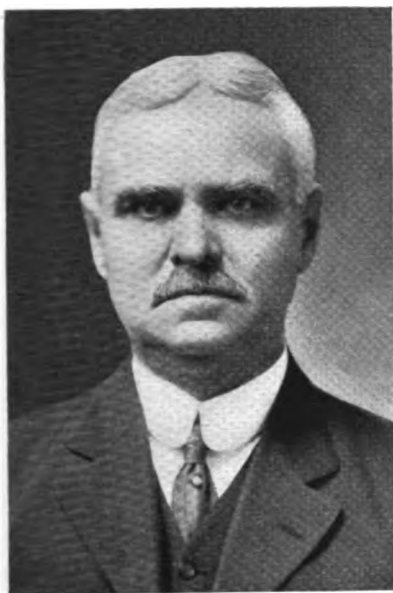
COMMITTEE ON PAPERS

LEWIS H. KENNEY, Chairman

ANNOUNCEMENT

MEETING OF MARCH 20, 1917, at WITHERSPOON HALL

THE paper of the evening, "The Panama Canal," will be presented by **Brigadier-General George W. Goethals, U. S. A. (Retired).**



Copyright Cliveden, Washington, D. C.
Courtesy Public Ledger

The paper will be illustrated with lantern slides and motion pictures.

Members of Affiliated Societies are cordially invited to attend.

Members of the Club and Affiliated Societies are privileged to invite ladies.

PRELIMINARY ANNOUNCEMENT

APRIL 17, 1917.—*Regular Club Meeting, at the Club House.* The paper of the evening, "Submarines," will be presented by **Mr. W. A. Hall.**

APRIL 23, 1917.—*Junior Meeting at Engineers' Club.* Subject: "**Efficiency Engineering.**"

MEETINGS FOR JUNIOR MEMBERS

MARCH 26, 1917.—*Meeting at the Engineers' Club.* Subject: "**Organization and Work of the Bureau of Highways.**"

1. ORGANIZATION.

By **J. B. Moran.**

2. TESTING MATERIALS.

By **H. I. Goldstein.**

3. MAINTENANCE OF WATER COURSES AND MEADOW BANKS.

By **H. M. Packer.**

Junior members are privileged to invite friends to the meeting.

PRIZE FOR JUNIOR MEMBERS

See November issue of PROCEEDINGS, Page 5, for rules governing the award of prize for Junior Members.

All papers must be submitted to the Committee on Papers, on or before March 31, 1917.

Engineers' Club of Philadelphia

SECRETARY'S NOTICES

A BUSINESS Meeting of the Club will be held Tuesday evening, March 20, 1917, at 8.15 o'clock, at Witherspoon Hall. The Committee on Nominations will present its report at this meeting. The report of the Tellers on the vote on amendments to the By-Laws, Articles I to XII, inclusive, will be announced. *Paper:* Brigadier-General George W. Goethals (Retired) will address the meeting on "The Panama Canal." The address will be illustrated with lantern slides and motion pictures.

ROBERT H. FERNALD, *Secretary*.

ABSTRACT OF MINUTES OF THE BUSINESS MEETING OF THE CLUB

HELD TUESDAY EVENING, FEBRUARY 20, 1917

The meeting was called to order by President Carter at 8.15 P.M. About 65 members and guests were in attendance.

The report of the Tellers on the vote on amendment to Article XII of the By-laws, and the minutes of the Business Meeting of January 16, 1917, as printed in the PROCEEDINGS, were approved.

ANNOUNCEMENTS

The Board of Directors elected, at its last meeting, the following to membership: Active, 19; Junior, 4.

Mr. Herbert A. Terrell, member of the Technology Club of Philadelphia, was admitted to Active membership in the Club, January 19, 1917.

The proposed amendments to the By-laws, as submitted to the members, were discussed and approved without change, and ordered for letter ballot, in accordance with the provisions of Article XII of the By-laws:

Following the meeting, motion pictures on "Road Building" were shown by Dr. J. R. Squires, of the E. I. duPont Company.

An unanimous vote of thanks was extended Dr. Squires.

The meeting adjourned at 9.50 P.M.

ROBERT H. FERNALD,
Secretary.

REGULAR MEETING OF THE BOARD OF DIRECTORS

FEBRUARY 13, 1917

The meeting was called to order by President Carter at 8.15 P.M., with Vice-presidents Vogelsson and Andrews, Directors Murray, Wagner, Gibson, Crampton, Bullens, Past Presidents Taylor, Swaab and Ledoux, and Secretary Fernald in attendance. Vice-president Yarnall and Treasurer Irish were excused. Directors Liversidge, Temple, Bachman and Cassell were absent.

The minutes of the Regular Meeting of January 9, 1917, as issued to the Board of Directors, were approved.

REPORT OF THE PRESIDENT

The President announced the appointment of Mr. William H. Connell as a delegate to represent the Club at the American Good Roads Congress at Boston, February 5th to 8th.

The President announced that, in accordance with the invitation of the Philadelphia Chamber of Commerce, he had suggested the names of several members of the Club, who were also members of the Chamber of Commerce, to serve on some one of their committees.

It was announced that the resignation of Mr. Henry Hess from the Committee on Finance had been accepted, and that Mr. Lewis H. Kenney had been appointed to fill the vacancy thus caused.

REPORT OF THE SECRETARY

In accordance with motion No. 399, February 8, 1916, Board Minutes, the difference in dues between Active and Junior membership was remitted for the following members, for the fiscal year April 1, 1917, to March 31, 1918:

Edwin von K. Borchard	Walter S. Fogg
Ernest Hagenlocher	Ragnar E. Hasselgren
Alexander Broadhead	W. A. Sloan
Alexander P. Gest, Jr.	Horace G. Leng
John B. Shallcross	Adam C. Warfel
F. Van Buren Connell	William F. Moody

It was announced that Mr. Herbert A. Terrell, member in good standing of the Technology Club of Philadelphia, had been elected to Active membership in the Club, January 19, 1917, in accordance with the By-laws.

The following deaths were reported:

Edmund G. King Active member, August 24, 1916.
Charles E. Hubsch, Active member, January 27, 1917.

The following resignations from members in good standing were presented:

Lester Bernstein	H. F. Galbraith
J. A. Boers	John W. Gray
Frank Brown	Harry B. Griner
F. S. Calderwood	F. Dickinson Shaw
C. E. Clewell	Edward G. Steinmetz
P. T. Dashiell	Geo. W. Williamson, Jr.
R. S. Francis	

Action: Resignations accepted as of March 31, 1917.

The Secretary announced that, in accordance with the By-laws, provision for Assistant Secretary must be made.

Action: Mr. Lewis H. Kenney was appointed Assistant Secretary for such time as he serves as Business Manager of the Club.

The Philadelphia Section of the American Society of Mechanical Engineers requested space in the Club library for a set of the Transactions of their Society, to be available for the use of the members of their Section.

Action: In view of the fact that the library space is very limited, and that a set of these Transactions is now in the library, the Secretary was instructed to notify the Society that it is not at the present time consistent to grant this request.

REPORT OF THE BUSINESS MANAGER

Ruling of the Board was requested as to whether or not the bills for annual dues shall be sent to the members on March 1st or April 1st.

Action: Board ruled that the bills be sent out on April 1st.

A report was presented on the subject of the official Club emblem adopted by the Board at its December meeting, suggesting the advisability of placing an order for 100 emblems, in order that the Club may be in a position to provide the members with emblems whenever an order is received.

Action: The Board granted authority to the Business Manager to place an order for 100 emblems, subject to the approval of the Committee on Finance.

The Business Manager recommended that a Committee on Increase of Membership be appointed.

Action: The President was authorized to appoint a Committee on Increase of Membership.

REPORT OF THE TREASURER

The Treasurer presented a statement of the financial condition of the Club.

Action: Report accepted.

REPORT OF THE COMMITTEE ON FINANCE

The Chairman presented a report of the unexpended balances to January 31, 1917, on the various committee appropriations. He also stated that at the meeting of the Committee on Finance, the action of the Board on the transfer of the appropriation of \$50, or such portion thereof as would be needed, from the Committee on Membership to the Committee on Papers was ratified.

Action: Report accepted.

REPORT OF THE COMMITTEE ON HOUSE

The Chairman reported that, during the month of January, the restaurant business showed a net gain of \$62.87 and the house business a loss of \$325.63. The number of meals served in January reached the highest point in the history of the Club—2971, averaging 96 meals per day, an increase of 23 per cent. over the previous

month, and an increase of 89 per cent. in the past six months.

The Chairman also reported that, owing to the greater demand for restaurant facilities, the ladies' dining-room had been discontinued, as such, on the first of February.

Action: Report accepted.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The Committee presented a report, recommending that the following be elected:

To Active Membership:

Gustav A. H. Binz	Robert D. Hawkins
William Y. Borresen	Nelson D. Herst
Louis K. Carroll	Harold C. Lightfoot
H. R. Cobleigh	John G. Maguire
Walter J. Denny	Walter S. Miller
Henry L. Dowell	Edward T. Peters
Conard M. Gilbert, Jr.	Roland L. Rudrauff
David S. Ferree	George C. Souder
Charles D. Gulick	Alexander G. Spencer
Samuel K. Haslam	

To Junior Membership:

Edward P. Bredin	Robert E. Fritsch
Harry B. Floyd	Earl N. Newlin

Action: Recommendation approved.

REPORT OF THE COMMITTEE ON PUBLICATION

The Chairman stated that Mr. W. R. McLain, a member of the Club, had agreed to become advertising manager of the PROCEEDINGS.

He announced that Miss R. F. Vickers had been appointed Secretary to the Committee.

The Chairman announced that the columns of the PROCEEDINGS are open to Committees for their announcements, and requested that the Chairmen make use of the columns to present to the membership the subjects under discussion by the Board.

Action: Report accepted.

REPORT OF THE COMMITTEE ON PAPERS

The Committee presented a report on the meeting held at Drexel Institute, January 20th, on "The Zoning System," and requested that the Board formally acknowledge the courtesies extended on that occasion by Dr. Hollis Godfrey, President of Drexel Institute.

Action: Report accepted.

The Secretary was instructed to extend a vote of thanks to Dr. Godfrey and his assistants, and to also extend a vote of thanks to Mr. E. M. Bassett and Mr. George B. Ford, the speakers of the evening, and to Mr. George E. Datesman and Mr. Andrew Wright Crawford, who discussed the paper.

REPORT OF THE COMMITTEE ON MEETINGS

The Chairman presented a report, suggesting that the Board rule that the charge for each evening's use of the motion picture machine to other than affiliated societies be \$15.

Action: Recommendation approved.

ENGINEERS' CLUB OF PHILADELPHIA

REPORTS OF SPECIAL COMMITTEES

Committee on Public Relations

The Committee presented the following resolutions for such action as the Board should deem appropriate:

"*Resolved*, That The Engineers' Club of Philadelphia pledges its whole-hearted, loyal support to the President of the United States in any emergency that may arise from his stand for the maintenance of the rights of the United States of America.

"*Resolved*, That it be recommended to the Board of Directors of the Club to institute an inquiry, designed to determine in what particular line or lines each member of the Club would feel best prepared to serve the United States Government in case of need, either in active duty, or in any other capacity for which he may be fitted."

The Committee stated in its report that it is not the intention of the Committee that the list of members' capabilities which it is recommended should be obtained should be turned over to the Government officials at this time, but should be merely filed in the Club office, so that, in case of need, the information can be obtained on short notice.

Action: The Board ordered that the resolutions be transmitted to the Club for action.

The President announced, in this connection, that he had received a petition, signed by twenty-eight members of the Club, requesting that a Special Meeting of the Club be called to consider the matter of the Club's offering its service to the Government in case of need. The President stated that he had replied to the twenty-eight members that the Committee on Public Relations was considering this question, and that its action would be announced at the next Club meeting.

Committee to Secure Club Manager

The Chairman stated that, owing to the indefiniteness regarding the possible appointment of an Executive Secretary, after the revision of the By-laws, the Committee decided that, for the time being, a tentative appointment to the position of Business Manager should be made, and reported that Mr. Lewis H. Kenney, who is so thoroughly familiar with the details of the Club, has agreed to assume the duties of Business Manager until the question of Executive Secretary has been definitely determined.

The Chairman stated further that the Club business was running very smoothly, and that a great deal of credit is due to all concerned with carrying forward the many details for their hearty co-operation, and especially to the Chairman of the Committee on House, Mr. Andrews, who has devoted a great deal of time to the affairs of the house.

Action: Report accepted as progress, the Committee continued, and the members of the Committee commended for their good work.

Committee on Club Development

The Chairman reported definite comprehensive plans for extending the facilities of the Club. The questions involved were discussed at length.

Action: To meet temporary demands, the President and Treasurer were authorized to arrange for the transformation of the present conservatory into an addition to the private dining room.

Committee on Club Banquet

The Committee presented a report, outlining the propositions presented by the Chairman of the Committee on Club Development, and suggesting that a Club Banquet be held, possibly on Friday, March 30th, 1917. The Committee also requested definite information from the Board as to whether or not to proceed with the banquet along the lines suggested in its report.

Action: The Board approved the recommendation of the Committee that the Club Banquet be held March 30th, 1917, and instructed the Committee on Club Development to prepare a plan of procedure for presentation at the banquet, in accordance with the program suggested by the Committee on Club Banquet.

ROBERT H. FERNALD,
Secretary.

ABSTRACT OF MINUTES OF THE SPECIAL MEETING OF THE CLUB

HELD FRIDAY, JANUARY 26TH, 1917, AT DREXEL INSTITUTE:

THE meeting was called to order by President Carter at 8.30 P.M. About 400 members and guests were in attendance.

Papers were presented on "The Zoning System" by Mr. Edward M. Bassett, Chairman of the Heights of Buildings Commission and Chairman of the Commission on Building Districts and Restrictions, New York City, and Mr. George B. Ford, Consultant to the Commission on Building Districts and Restrictions, New York City. The papers were discussed by Director of Public Works George E. Datesman and Secretary of the Art Jury Andrew Wright Crawford.

After the meeting, the members and guests proceeded to East Hall, where an exhibit of maps, illustrating the Zoning System in New York, was explained by Messrs. Bassett and Ford.

The meeting adjourned at 10.30 P.M.

LEWIS H. KENNEY,
Secretary pro tem.

Engineers' Club of Philadelphia

COMMITTEE ON MEMBERSHIP

D. ROBERT YARNALL, Chairman

CANDIDATES FOR MEMBERSHIP

Members having knowledge of the candidates are invited to submit to the Committee on Membership before March 12th a confidential expression of opinion as to the eligibility of the candidates; all communications to be addressed, "Chairman of the Committee on Membership, Engineers' Club, Philadelphia," marked "Confidential."

All applications are on file at the Club and can be referred to by any member.

FOR ELECTION TO ACTIVE MEMBERSHIP

EDWARD T. ADAMS

3613 N. 19th St., Phila., Pa.

Secretary, The Juniata Furnace & Foundry Co.

Proposed by F. K. Worley, H. A. Moore and J. Reese Bailey.

EDWARD R. ARMSTRONG

863 du Pont Bldg., Wilmington, Del.

Engineer, E. I. du Pont de Nemours Powder Co.

Proposed by Harold L. Miner, Robert G. Bruce and A. T. Lewis.

HERBERT KELLER BEAR

4032 Baring St., Phila., Pa.

Chemist, Vice Pres. & Treas. of Bear Engine & Casting Co.

Proposed by R. P. Farrington and J. H. M. Andrews.

PERCY DALLES BROWN

617 N. 34th St., Phila., Pa.

Transitman, Engr. Dept., Pennsylvania R. R. Co.

Proposed by Frederick F. Shoemaker and Fred W. Duemler.

CARL FREDERIC PEALE CARRIER

406 S. 16th St., Phila., Pa.

Testing Engineer, Atlantic Refining Co.

Proposed by Albert H. Schmidt, M. L. Mosher and Lester M. Goldsmith.

FRED F. CHAPMAN

E. I. du Pont de Nemours Powder Co., Wilmington, Del.

Chemical Engineer, E. I. du Pont de Nemours Powder Co.

Proposed by Henry Voigt and Curtis C. Meigs.

CHARLES G. COPE

Stock Exchange Bldg., Phila., Pa.

Secretary-Treasurer The Driscoll Co.

Proposed by Walter Loring Webb and James L. Fawley.

CLEMENT EDWARD CROWLEY

618 Perry Building, Phila., Pa.

Civil Engineer, Green Starr Engineering Co.

Proposed by F. N. Gifford and Oliver F. Starr.

PETER P. G. HALL

Bridesburg, Phila., Pa.

Secretary and Treasurer, Hall Gas Engine Co., Inc.

Proposed by George E. Lawrence and Lewis H. Kenney.

GEORGE WASHINGTON HERMAN

4820 N. Carlisle St., Phila., Pa.

Engine Designer, Southwark Fdy. & Machine Co.

Proposed by George M. Spear and W. A. Leavitt, Jr.

WILLIAM F. HUDSON

3349 Richmond St., Phila., Pa.

Manufacturer Auto Trucks.

Proposed by Minor Harvey and S. M. Swaab.

ROY SCHOFIELD HUTCHISON

N. W. Cor. 3rd and Arch Sts., Phila., Pa.

Sales Engineer, Howard W. Read Co.

Proposed by Robert J. Bonstein, Harry W. Thompson and Carl Harrington.

STANLEIGH O. KELLEY

418 Federal St., Camden, N. J.

Power Salesman and Electrical Engineer.

Proposed by Joseph H. Myers and J. W. Magee.

WILLIAM S. NASH

3615 N. 19th St., Phila., Pa.

Machinery Business, The Geo. W. Blabon Co.

Proposed by J. Reese Bailey, W. F. Drueding and H. R. Kern.

JACOB M. NOLL

745 Merrick Ave., Collingswood, N. J.

Chief Draftsman, Warren Webster & Co.

Proposed by William F. Bilyeu, F. Joseph Miller and J. Logan Fitts.

KARL R. PETERS

2112 Sansom St., Phila., Pa.

Prop. of Ludlow Auto Eng. Co.

Proposed by F. A. Saylor and Chas. H. Storm.

HENRY L. PRICE

Lansdowne, Pa.

Travelling Auditor, Penna. R. R. Co.

Proposed by Alfred A. Townsend, Fred C. Dunlap and George W. Townsend.

LEWIS MATLACK THOMPSON

2335 N. 31st., Phila., Pa.

Assistant Electrical Engineer, du Pont Powder Co.

Proposed by H. L. Miner and Robert G. Bruce.

FOR ELECTION TO JUNIOR MEMBERSHIP

GEORGE CHARLES WHEELER

226 W. Johnson St., Gtn., Phila., Pa.

Chemical Engineer Clerk, Tungsten Plant, Midvale Steel Co.

Proposed by E. D. Bransome and R. C. Link.

W. H. SHUSTER, Jr.

2307 N. Fairhill St., Phila., Pa.

Industrial Engineer, Curtis Publishing Co., Phila.

Proposed by Wm. J. Doyle, Jr., and W. M. Boehm.

As We Pause by the Wayside

S. M. SWAAB

PAST PRESIDENT, CHAIRMAN OF THE COMMITTEE ON CLUB DEVELOPMENT

TO accomplish anything in life worth while, we must have high aspirations and lofty ideals, and to the accomplishment of our ideals we must dedicate the best that is in us. This being so, we must unceasingly and unremittingly direct our ambitions to the accomplishment of our ideals above all else; and in so doing it is desirable that we aim at something big—because we are less likely to miss, and we are sure to hit the target some place, if not in the bull's eye, while if the target were only as big as the bull's eye we might miss it entirely. One other reason why we must set our ideals high is because it requires bigger men to reach such ideals, and, incidentally, we will get the benefit of the training, even if we don't accomplish all we attempt.

On the other hand, if we are determined to accomplish our aim, we shall not fail. When the French Convention inquired of Napoleon, then quite a young man, whether he would assume to take command, he replied, "I am in the habit of accomplishing that which I undertake." Therefore, I say, make the goal sufficiently important, and we will all work together for its accomplishment, and the Club will be the gainer.

During many years we have been making progress slowly, but we can't continue at our usual pace in these strenuous times when time is precious and is held at a premium. If we are to accomplish great things, we will have to dream, then we will have to exert ourselves; and once we overcome the normal inertia and exert all the energy that is in us for the consummation of the purpose we have in hand, nothing under heaven will prevent our accomplishing the task we have set before us. If I may be allowed to quote from the Scriptures an injunction that is apropos, I would say that, "Whatsoever thy hand findeth to do, do it with thy might."

When we were a puling infant, gasping for breath, we were not satisfied, and when we occupied the youthful stage we were still unsatisfied, and now that we are grown to mature manhood—well, the truth is, we are still striving to accomplish greater things.

The Committee on Club Development has under consideration a plan which, when it is consummated, will place the Engineers' Club in its proper position in the constellation in which it stands in this community; and the entire proposition will be laid before the Club members just as soon as some few of its details have been more fully developed.

Welfare Work

A Typical Example of the Interest Leading Manufacturers are Taking in Their Employees' Welfare

By JOSEPH CACCAVAJO

THIS is not a story about the products manufactured by the Nelson Valve Company and the Yarnall-Waring Company. The fact that these two companies which occupy the same plant at Chestnut Hill are numbered among the prominent and highly successful establishments for which Philadelphia is noted and of which every Philadelphian is justly proud speaks for itself, moreover I did not go out to inspect the products of the two companies, but rather to confirm the many highly complimentary statements I had heard about the wonderful equipment of the plant and the arrangements provided not only for manufacturing purposes, but also for the safety and comfort of its employees.

Practically all of the executive and administrative heads of the two companies are members of the Engineers' Club of Philadelphia; Mr. Yarnall, the Vice President and General Manager of the Nelson Company, being a Vice President and an active member of the Club, so that every possible opportunity to thoroughly inspect the plant was extended to me. I spent more than five hours in the shops, every minute of which was filled with interest, and I came away very much impressed with the fact that while there were no evidences of hurry anywhere in the plant, the work was going on steadily and effectively without friction or lost motion and the men and women employees showed conclusively that they were not only interested but pleased with their work.

More than half the battle in any job is to like your work and if I am any judge of human nature, those employed at the Nelson Works, from the Vice President and General Manager down to the boy who cleans the

sand out of the castings, are finding real pleasure as well as interest during the hours they are at the plant.

The illustrations published herewith show the style of the buildings which are constructed of steel and concrete, with roofs of red concrete slab. The immense skylights are constructed of wire glass and the huge windows which completely encircle each of the buildings give free access to light and sunshine. The buildings contain more than 160,000 square feet of floor space. The surroundings, inside and out, are pleasant and there is not a dark corner or an unnecessarily unclean spot anywhere about the entire plant.

Judged by past experiences when you start out to inspect a manufacturing plant which includes foundries and machine shops, you would naturally put on your old clothes and prepare yourself to encounter a dirty, noisy place filled with the odors of hot metal, oil and grease. I had been told that the Nelson Plant was a wonderful establishment, but I was hardly prepared to find conditions which compare favorably with the Bell Telephone Building, which some 600 or more members of the Engineers' Club inspected a few months ago. A machine shop that has wide aisles and is almost as clean and wholesome as the most modern of our department stores is surely an innovation if not an inspiration.

Walking through a half dozen or more buildings covering a considerable area, you could not help being impressed with the scrupulous cleanliness, the neat arrangement of the equipment, ideal lighting, heating and ventilation, all of which have been studiously and carefully provided. The day was cold, but it was as comfortable in the shops



MAIN OFFICE BUILDING

as it was in the office. Nothing seems to have been neglected which would in any way add to the comfort of the men and women while at work. Everywhere about the shops are mechanical devices, overhead trolley systems, etc., to save the employees from unnecessary strains and to conserve their energy so that they may finish the day in fit condition and not be completely exhausted by two or three o'clock, as is so commonly the case in those branches of industry which require the handling of heavy material and severe manual labor.

During the past few years the engineering magazines have devoted much space to the subject of welfare work, and have cited many notable examples of the benefits derived by manufacturers, directly and indirectly, from their investment along this line.

I recall one incident that was related to me quite recently by a manufacturer in another city. In speaking of his welfare work, he said: "Take the labor question, for instance. We have lost none of our old employees, and we have had very little trouble getting new men for the reason that we have the reputation of giving everybody a square deal.

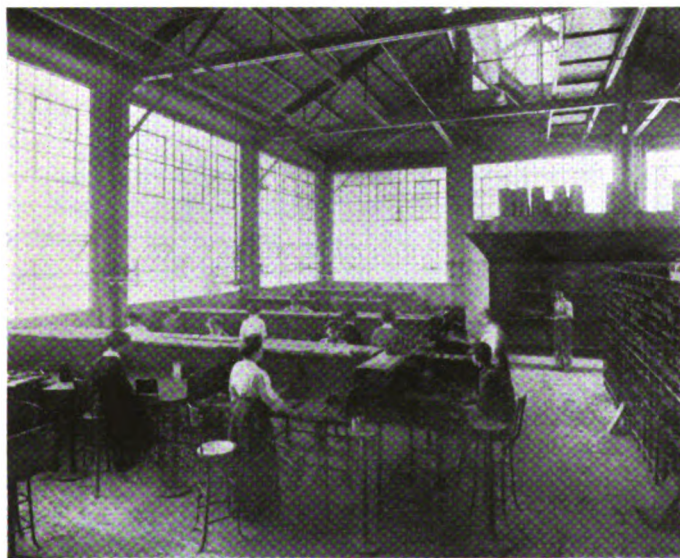
"I consider the money spent in making our employees happy and comfortable one of the best investments we have ever made, although at the time the movement was started we did not realize the possible return we would get on the investment. The movement was started first in a small way; a few improvements that we thought might benefit the men were undertaken, such as the instal-



BRASS AND BRONZE FOUNDRY

ladies, comfortably seated and engaged in making what children would call "mud pies." The moulds and the sand piles looked for all the world like the equipment of an up-to-date kindergarten where the children are taught to mould sand and clay into all kinds of queer shapes, only here instead of making clay horses and cows the young ladies were making sand cores for use in the brass and bronze moulds. In moulding hollow castings the core used must be made of material which will break readily and it is really fascinating to watch the dexterity and speed with which the young women make the sand cores and place them on large flat tins ready for the bake ovens.

Every little while a man picks up one of these tins loaded with dozens of these queer shaped "mud pies" and puts them in the oven just like they handle cakes in a bakery. The work-room is so well lighted, everything about the shop is so clean and everybody seems to be enjoying their work so much, that it is difficult to imagine that it is all part of a day's work and an actual manufac-

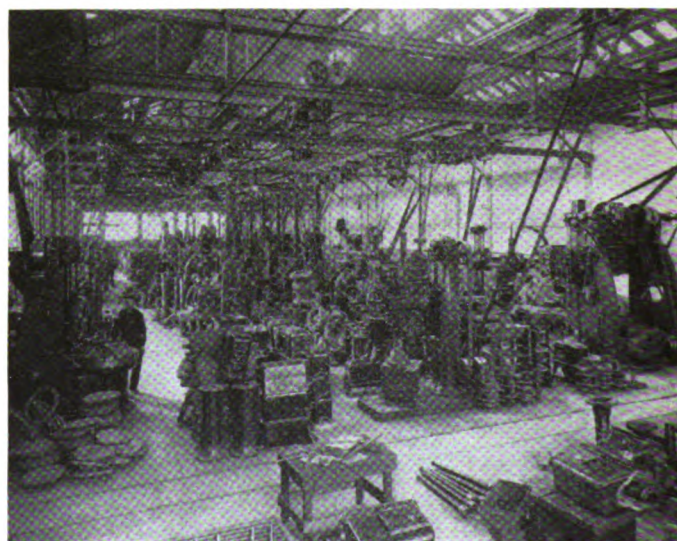


CORE ROOM, BRASS AND BRONZE FOUNDRY

lation of a lunch room with proper facilities for cooking.

"We next installed a proper wash room, equipped with showers. The favorable comments from the men led us to believe that we were on the right track, and we have never regretted the investment."

One of the interesting sights encountered almost immediately upon entering the plant was a dozen or more bright-eyed, intelligent and neatly dressed young



SECTION OF MAIN MACHINE SHOP



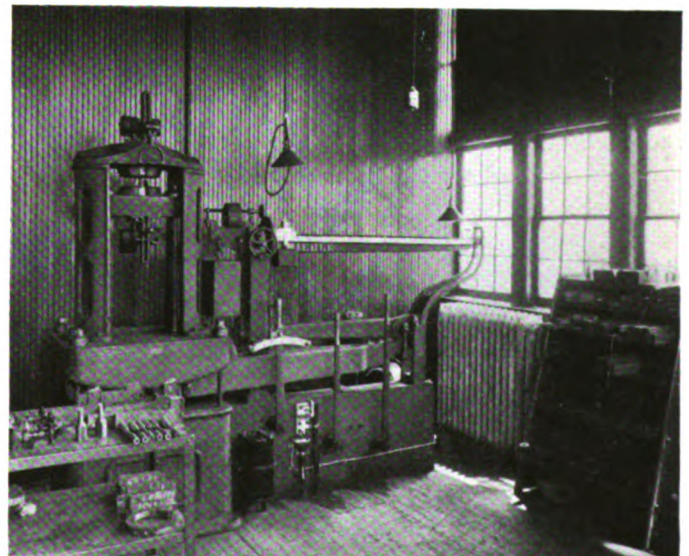
BRASS MACHINE FINISHING SHOP

turing process. Best of all it was pleasing to learn that the girls engaged in this work earn as much if not more than those employed in office work.

From the section where the girls were making the sand cores it was but a few steps into the Brass Foundry, and here, strange as it may seem, there were no evidences of rush or unnecessary dirt. The molten metal is carried in a specially designed carrier on an overhead trolley, thus eliminating the possibilities of spilling the metal or injuring the workmen, as is not uncommon where the ladles of metal are carried by hand. The floor space is divided and sub-divided and the forms are neatly laid out where they can be readily reached from the trolley system. In fact, every possible detail shows studied method and arrangement and as a consequence it is a pleasure to watch the men at work.

The making of immense moulds by machinery as well as the cutting, cleaning, sand blasting and testing of the rough castings is all done without the slightest lost motion. Every order that enters the shops is "routed" and can be followed through all the different processes of manufacture from the time the metal is thrown into the crucible until the destination tag is attached in the shipping room and the finished article or articles are put into the freight car which stands at the loading platform inside of one of the buildings.

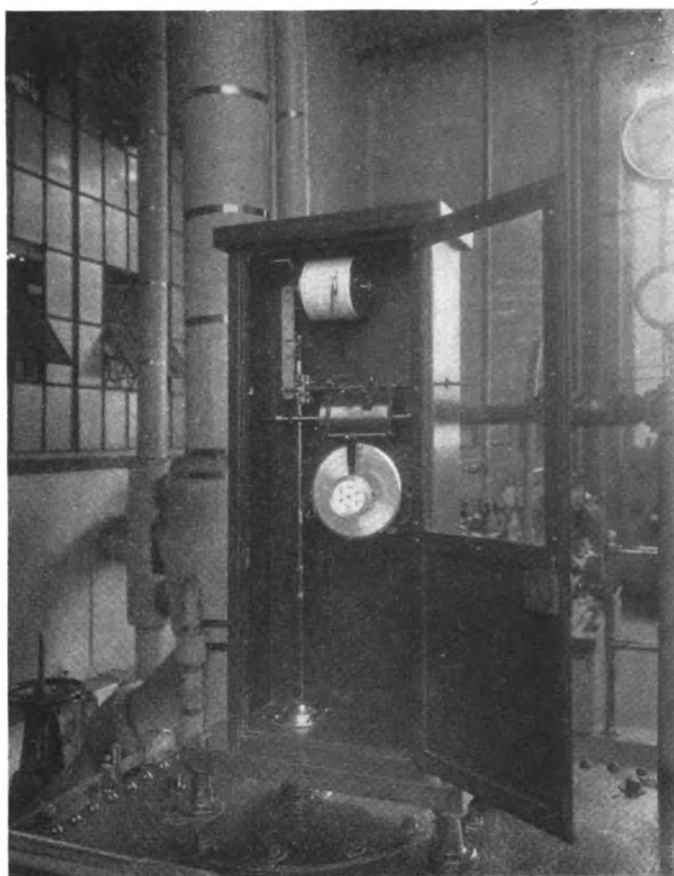
The activities in the Brass and Bronze Finishing Shops remind one of the pictures which we see so often these days of the great munition plants, only here the products have nothing to do with war or the destruction of human life and property. There is no crowding anywhere and still there is no waste of either space or equipment. Every



PART OF PHYSICAL TESTING MACHINERY

piece of machinery has been made "fool proof." The latest safety devices, screens and protective appliances have been provided and the wisdom of this is shown by reason of the fact that few serious accidents have occurred at the plant. In the event of accident, however, first aid facilities are provided in the very complete hospital and operating room maintained by the Company. In this, as in all other things connected with the plant, every possible contingency seems to have been anticipated and provided for.

Materials of all kinds are handled in metal boxes of a uniform size which can be readily picked up by the overhead trolley system, and these boxes can be built up in



RECORDING METER IN ENGINE ROOM

racks similar to sectional bookcases, all of which helps to maintain the orderly appearance and cleanliness already described.

Not the least interesting device is the appliance for cleaning and separating the sweepings of iron, brass, bronze, steel and other metals, probably an old story to those engaged in the manufacturing of metal goods, but nevertheless interesting to a rank outsider.

When the Club visited the Navy Yard last summer, many of the members commented on the arrangement and spic and span cleanliness of the tool rooms aboard the warships. The tool and gauge room at the Nelson Works compares favorably with the best the Navy Yard can show; the same can be truthfully said about the pattern shop and pattern storage room, which is in a large fire-



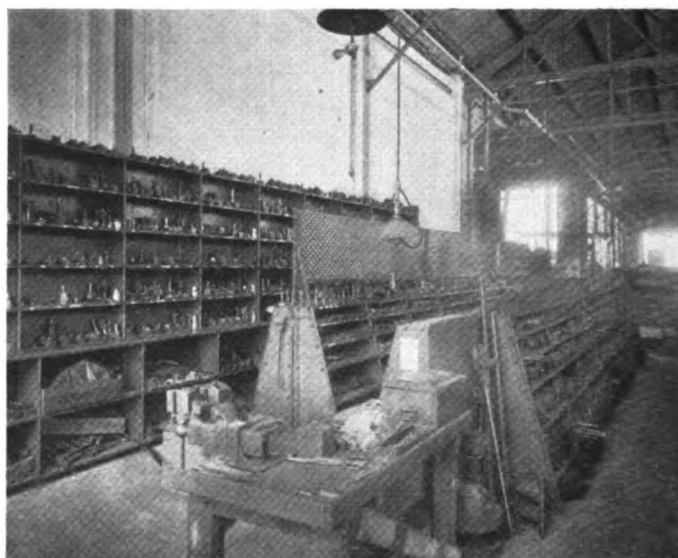
CORNER OF DRAFTING ROOM

proof building and contains thousands of wooden models of all sizes and descriptions. Even in this room there is no confusion, everything has a place and is where it belongs. You do not have to be told that any and everything in the shop is readily accessible and can be produced at a minute's notice.

The engine room is a model of perfection in design and cleanliness, reminding one of an exhibition plant on view at a great industrial exposition rather than the working plant of a manufacturing establishment engaged in making castings, tools and mechanical equipment. Here again the visitor cannot help but realize the wonderful regard for the fitness of things which permeates every one of the several departments throughout the plant.

What has been said of the Brass Foundry and the Brass Finishing Shops is equally true of the shops where iron and steel, as well as other metals, are used.

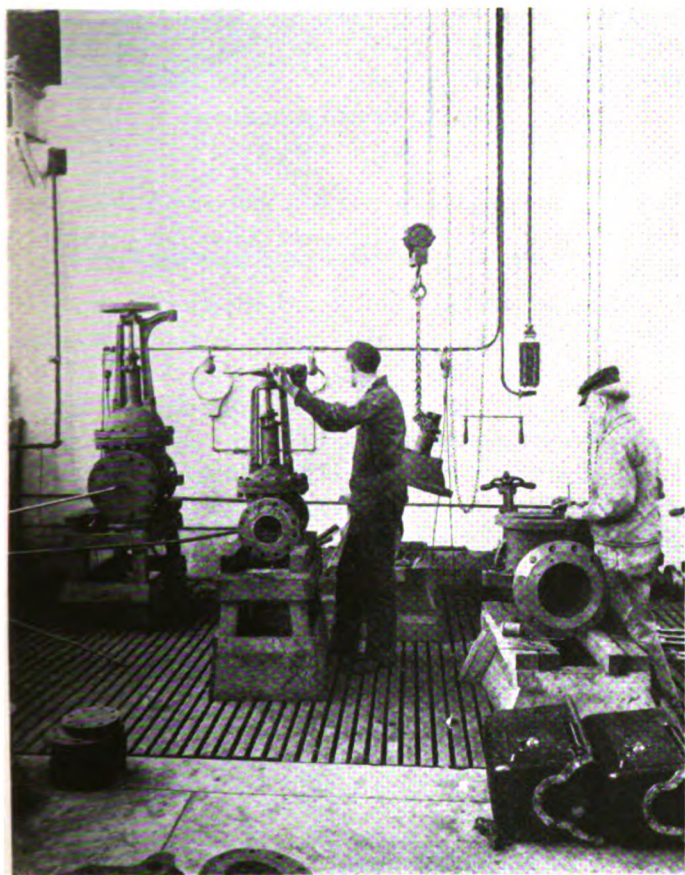
The buildings in addition to being comfortably heated are designed so as to give adequate ventilation. The machinery and mechanical equipment is maintained at a



TOOL AND GAUGE ROOM

high standard of perfection and the deafening rattle and bang usually found in machine shops is strikingly absent. As a consequence the nervous strain which usually attends working in the midst of moving machinery is greatly minimized.

In addition to its group of well-constructed up-to-date office and manufacturing buildings, the Company maintains a large number of well-built homes for the employees, which are designed and kept up with the same foresight and care for detail that marks everything connected with the establishment. The rents are reasonable and monthly prizes are offered to the families who take the best care of their homes, have the best yard or best garden or flower beds. Each year a large plot, covering several

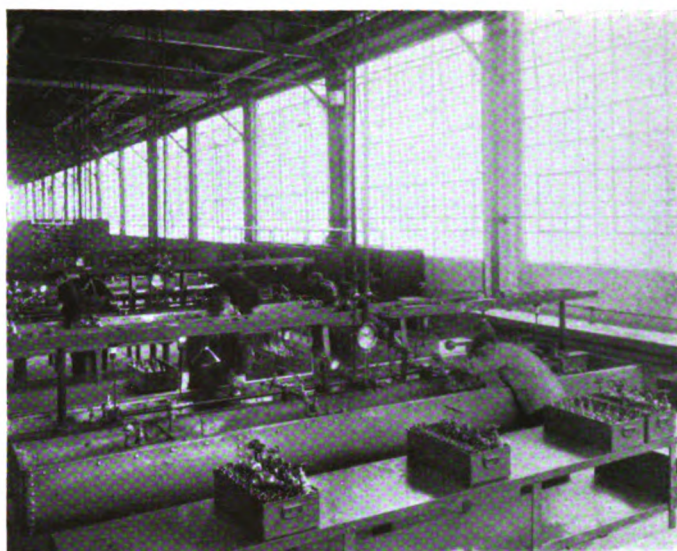


ONE CORNER OF TESTING ROOM

acres, is plowed up and divided into sections which are assigned to different employees and upon which they are encouraged to plant vegetables and garden truck. Prizes are offered and an exhibition of the produce grown on these plots is held at the end of each season, at which special prizes and money are given the same as at a regulation county fair.

A sewage disposal system which cost upward of \$15,000 has been built, and, in addition to city water, there is an artesian well capable of supplying 100 gallons a minute.

The wages paid at the Nelson and Yarnall-Waring Works are above the average, and in addition a special system has been instituted which has met with the general



TESTING BRASS VALVES

approval of the employees. By means of a series of recording devices, the time spent by each man is accurately kept and this, in conjunction with a liberal bonus system, puts a premium on good service. The men are encouraged to take a personal interest in the work and are made to feel that in working for and with the Company, they are working among friends and are entitled to share in the success of the plant.

There is a mutual benefit association, into which each employee pays ten cents a week. The fund thus secured provides the attendance of a physician for one hour daily in the well-equipped hospital provided by the Company. Medicine is furnished without extra charge. In case of illness the doctor calls at the home of the employee until he or she has entirely recovered and \$5 a week sick benefit is paid for a period of three months. In the event of death the sum of \$75 is immediately paid to the family of the deceased.

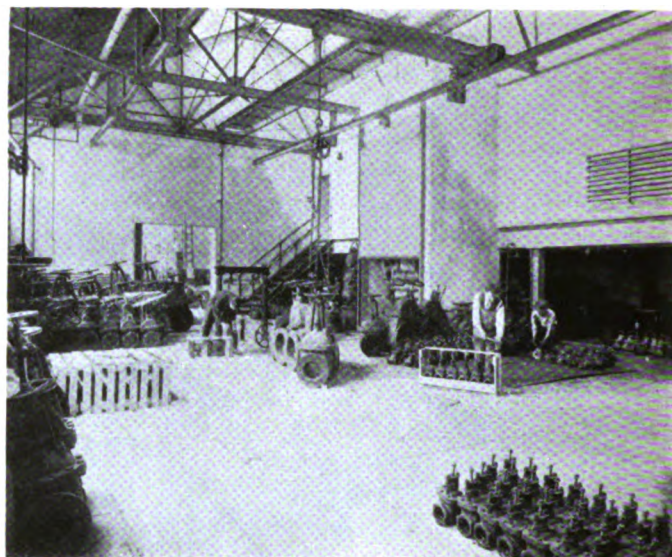
A Thrift Club was started, and at the present time almost every one of the 300 or more employees of the



ENGINE ROOM



VIEW IN HOSPITAL



CORNER OF SHIPPING ROOM

Companies has a savings account in his or her own name in the Germantown Savings Bank. While the Company takes care of these accounts, the amount deposited weekly depends entirely upon the personal wishes of the employees themselves.

All things considered, nothing within reason which will tend to make the employees healthier, wealthier, and happier has been neglected.

As stated at the beginning of this article, it was not intended as a description of the manufacturing products of the Nelson Valve Company and the Yarnall-Waring Company, but merely as a description of the work being

done by companies with which a number of the prominent members of the Engineers' Club are personally identified.

In the last analysis, however, I have no hesitancy in pointing out the fact that good workmen produce good work.

The methods pursued by these two companies cannot fail to produce good workmen. Under such conditions as exist at their plant, anything but the best possible results in workmanship and quality of goods produced is out of the question. The reasons for the continued growth and success of these two companies is therefore obvious.



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Chemical Research in Philadelphia*

BY DR. EDGAR FAHS SMITH

PROVOST, UNIVERSITY OF PENNSYLVANIA

HONORARY MEMBER ENGINEERS' CLUB

MR. PRESIDENT, Ladies and Gentlemen: Several months ago, the steering committee of the Club visited me in my office and prevailed upon me to consent to speak to the Society sometime after Christmas. I would not promise to speak before Christmas; I thought that after Christmas was a good way off, and perhaps

something might occur which would make it unnecessary for me to appear before the Club. Now I am in that unfortunate state where a thousand and one things require my attention, and the subject that was assigned to me has received very little thought from me.

I did not think that these young men, whom I know so well, would presume so far upon my good nature, as to tell me what I should

speak on. I rather thought I had reached such a time in life when I was at liberty to select my own subject, but they have given me the one which you find printed on the cards which were sent out, namely, "Chemistry" or "Chemical Research in Philadelphia."

It is just eleven years ago that I stood on this platform and welcomed the representatives of universities and learned societies to the celebration of the 200th Anniversary of the birth of Benjamin Franklin. On that evening, after welcoming our guests, I indulged in the history of the Society, known as the American Philosophical Society, a child of Benjamin Franklin, which had its birth in this city in 1743; and I resurrected, in the course of the hour which was mine, a number of facts which representatives of the oldest Philadelphia families who were present that evening often said were new to them. I think this evening I shall probably, in presenting the thoughts which are mine on this particular subject, resurrect some facts which are not known, even to you.

Before beginning my account of some of the early work in this city, let me say that I have always been interested in chemical research. I believe it is one of the things that not only our city and our state, but our country should foster—that every institution of learning and every laboratory, every workshop, should occupy itself in the endeavor to extend the borders of human knowledge.

I shall not go back to the time of Adam, but I shall go back to the beginning of the Nineteenth Century, in the City of Philadelphia. Things were done here then, in a chemical way, which were really epoch-making. I do not know whether you have heard it or not, but it has been my lot, more than once, to listen to persons speak of our city as a place that has never done anything. They really forget that the Declaration of Independence was written in this city; that the Constitution of the United States was framed here; that the first and most opulent bank in North America was founded here, and quite a number of other things. So, too, I think we have forgotten, or perhaps we never knew that, in the earliest years of the Nineteenth Century, we had in this city one who made contributions to our knowledge of chemical facts, which live to-day, although we cannot trace them to their discoverer.

I should like you to follow me briefly while I speak of the work of one who was born here in 1781. It was about the time he was twenty years of age that he made his first contribution to chemistry. This person was Robert Hare.

I do not think there is an individual in this company who ever saw him. He passed away in 1858. Those of us who are chemists ought to take more than ordinary interest in him, not only for himself, but for what he did, for the part he played in putting Philadelphia, as a centre of chemical research, upon the map. Only last evening, I heard a gentleman say that there was something wrong with our educational system, because young men were not in the forefront, that no man to-day was doing anything that attracted attention until he advanced well into life. Robert Hare was just twenty years of age when he made that discovery which we chemists appreciate, but of which too many people are ignorant. They pay too little attention to it. And what was that discovery? Briefly, this: He was playing with a common blow-pipe. Nearly everyone here knows what a blow-pipe is like. He was fully acquainted with its disadvantages, and his endeavor was to improve it. While striving to do this, it occurred to him that possibly,

* Regular Meeting Engineers' Club, Witherspoon Hall, January 16, 1917.

by introducing oxygen gas in the flame in which he was blowing, he could get greater heat, and then the next thought was that perhaps a mixture of oxygen and hydrogen gas, those two gases, might do something or other; that is he schemed—he strove and he succeeded in bringing these two important gases together in such a way that one burned within the other, and the flame of that burning combination had an intensity greater than chemists had ever enjoyed before.



We read in our textbooks of the oxy-hydrogen flame. The oxy-hydrogen flame came to light through the effort of Robert Hare. The intense heat which he there discovered was applied in various ways. In some of the old papers which may be found now and then in our second-hand book stores—papers from his hand—we read that, with the help

of this great heat, he was able to make silver and gold melt and boil like water; further, that he succeeded in melting platinum, one of our most refractory metals, and it, too, was not only melted, but made to boil.

To most persons, that observation would just have a passing interest. It perhaps would not hold their attention for any great while; perhaps it would not mean anything to them, but has it meant anything to the world at large—did it mean anything then? I fancy that, if we had lived at that time and consulted with chemists of that day, they would have told us this great heat which Hare has put into our hands is something for which we had been yearning for years and years. To-day, we know that the heat of the electric arc is doing splendid work, that achievements have been won by means of it that we never, thirty or forty years ago, thought possible. No one dreamed that we were to have a temperature above 3500 degrees Centigrade, and so, if we can go back in mind to 1801, and look upon this young man of twenty years, working with two well-known gases, oxygen and hydrogen, and by a peculiar device burning the one gas within the other, getting a heat sufficient to melt silver and gold and cause them to run like water, to melt platinum and make it boil like water, surely the excitement that prevailed then must have been great.

† was done by Hare must have been upon the tongue of everyone interested in the physical sciences.

But what mattered that great heat, that intensity? How was it to benefit anybody? Well, strangely enough there was associated with this young man at that period, or a little later, a person named Joachim Bishop, who,

becoming familiar with this oxy-hydrogen flame, acquired the skill that is most essential in the handling of that flame, and founded what were known later and to-day as the J. Bishop Platinum Works, at Malvern, on the Main Line. Every chemist in this room has probably used a crucible, a cone, or something else that was prepared at their factory. In other words, through this discovery of Robert Hare, a great industry arose in the young State of Pennsylvania, in the United States; an industry that helped to make Philadelphia known throughout the scientific world. That is one of the results of that early chemical research on the part of Robert Hare. He had not had an opportunity of studying abroad in the laboratories of the chemists of France or England or Germany. He acquired most of his knowledge from his own personal experimentation and the great work which he was doing with this combination of gases, at least in the beginning, was performed down at the intersection of Dock Street with Walnut Street, on the southwest corner, where stood a wedge-shaped building. In the basement of that building, Robert Hare contrived the means by which he could mingle those gases, the means by which he could deliver them through a common aperture, ignite them, and get that intensity of heat which he sought. It wasn't the home of his father; it was a boarding house, and in that boarding house congregated a group of men—young men—students of law, students of business, but he was the only student of the physical sciences. It was an exceedingly brilliant group of men; in it, Hare was a bright, particular star.

I might tell you a good many things in connection with that group of young men, who afterwards played such an important part in this city, and in this country, but my business is to talk about chemical research in Philadelphia, and what I have told you constitutes a part of the first investigation made here, an investigation of which men were glad to know. Furthermore, that intense heat which the oxy-hydrogen flame gave, led to the calcium light; the limelight; the Drummond light. Along the coast were light-houses illuminated in very primitive ways. When this discovery of Robert Hare became known, he showed how brilliant lime became when that oxy-hydrogen flame impinged upon it, and in consequence the light-houses were illuminated in that way. The Drummond light was nothing more than the old calcium light—limelight. So there was the second contribution which this boy of twenty made that affected thousands upon thousands of people.

We read in the history of our science of chemistry that on one occasion the miners of Cornwall, England, assembled in a great concourse, to pay their respects to Sir Humphry Davy, who had invented a safety lamp that made their lives down in the depths more comfortable and safer. I sometimes wonder whether those who went to sea did not feel as if they owed a debt of gratitude to this young Philadelphian who discovered the means by which the beacon lights on our shores were

made to burn more brightly—more surely—made their passage home safer. That was, I repeat, the second interesting point in connection with this early research.

Associated with Robert Hare, about the year 1802 or 1803, was a gentleman who afterwards became a promoter of scientific investigation in this country. I refer to Benjamin Silliman, who had been appointed professor of chemistry and natural philosophy in Yale University in 1802; but before he assumed the duties of his chair, he thought it would be well to go abroad to familiarize himself with the subjects that he had to teach. And where did he go; to Paris? To London? To Berlin? No, he came to Philadelphia. It was then the centre of scientific research. He came here to study chemistry under James Woodhouse, to study natural history under Benjamin Smith Barton, and anatomy under the great Caspar Wistar. So Philadelphia, even at that early time, attracted students from other parts of the Union. Benjamin Silliman, by direction of a representative of the State of Connecticut, went to the boarding house that I mentioned, down at the corner of Dock and Walnut Streets, and there fell in with the group of young men to whom reference has been made, and when Robert Hare discovered or learned that Benjamin Silliman expected to study chemistry under James Woodhouse, he sought him out, called his attention to what he was doing down in the cellar of that house, and invited him to assist him, and Silliman's diary says that the oxygen gas, which they used in getting the oxy-hydrogen flame, was liberated from chlorate of potash, just as we do to-day; that Hare insisted on heating this salt in large retorts made of glass rather than stoneware, and the consequence was that, with the heat to which the glass was exposed, there followed very frequently breaks or explosions, and, as Silliman was paying for the retorts, the research became rather costly, so far as he was concerned, but he was content to advance the necessary funds, because of the knowledge which he was gaining. He had fallen in with one who really knew practical chemistry—one who, although young in years, was in a certain sense a master, and this all happened about 1802 or 1803; and again in 1804—Silliman came down from New Haven, and at about that time began the application of the oxy-hydrogen flame to the melting of platinum, and its use in the lime-light, the Drummond light, and its application to a number of other things which time forbids me to mention.

I want to get before you that picture. I often go down to the intersection of Dock and Walnut Streets. The building in which these two young investigators worked does not stand to-day, but I try in imagination to see it.

I have often wondered why it was that Robert Hare worked down there in the basement of that boarding house when he had his father's house in the city open to him. Perhaps some of you know that his father was a brewer. He had a brewery up on Front street, in the direction of Callowhill, and young Robert Hare was

also a brewer, but in his moments when he was not occupied with brewing, he was making investigations such as I have just recited, and Benjamin Silliman says in his diary that, down in that house, where they all met about the table, everyone of the diners or boarders was provided with—well, a drinking vessel, and, as Robert Hare's porter stood in good repute, they nearly all imbibed and enjoyed it. When Silliman went back to his New England home, I used to fancy that he forgot Robert Hare's brewery, although I have since learned from old letters that, even up to their old age, he sent, by ships sailing from Philadelphia to New York, and from New York to New Haven, large casks filled with the Hare product, to be consumed in that New England town called New Haven.

Now, I dare not tarry too long on this side of my story, but I want you to bear in mind when anyone talks about the limelight or the Drummond light, or the oxy-hydrogen flame, and the intense heat of that flame, that we owe all those things to a Philadelphia boy, just twenty years of age when he first made them known. Do you know that he exhibited that oxy-hydrogen flame and melted quartz and flint and some of the most refractory mineral substances, in the presence of Joseph Priestley, the old dissenter, who came from England, and died in Northumberland, Pennsylvania—Joseph Priestley, who was probably the founder of the Unitarian Church in the City of Philadelphia, and maybe in the United States of America? Yes, Hare exhibited the melting of platinum, the fusion of refractory mineral bodies, to Joseph Priestley, and I often wonder how that old discoverer, that man who made oxygen gas known to the world, must have felt when this lad of twenty showed him a use of the gas which never could have entered his thoughts.

Those of you who lived when Doctor Hare was living, saw a man who saw Joseph Priestley, the discoverer of oxygen. While only those who really care for ancient history would enthuse over this story, it sticks to me, and I must get it out, when I am given the opportunity, as I have been to-night; but I must go along with Robert Hare, because I have other people about whom I want to talk.

I think that it is a real down-right shame that we cannot find the name of Robert Hare in the Encyclopædia Britannica, as one of the great scientists of America. There are only about thirty-two scientific men in the new edition of the Encyclopædia Britannica, who were born in the United States, and I wondered why this was—that this man who did something which made many, many other things possible for us, why he should not have been mentioned, and why it is that, when you do find his name mentioned, he is always accredited to France. I cannot see how you could pronounce H - a - r - e in such a way that you could say it was a French name, but in the Annals of Physics and Chemistry, which is the most powerful scientific organ of France, about the year 1840, we read of the oxy-hydrogen flame; we read of the lime-light, and the Drummond light, and many other things

which were discovered by Hare, "a Frenchman." The truth of the matter is that Robert Hare was an Englishman, or his father was. His mother was a Philadelphia lady of the Willing family.

What shall I take next? Let me see. To-night, there may be electrical engineers here, or chemical engineers or even chemists who know something about electricity, who know that, away back in 1792, an Italian by the name of Volta constructed a battery called the voltaic pile, or volta cell, Volta's battery, which consisted of disks of zinc and silver, and then above a disk of leather, moistened, and then zinc and silver, and so on to any height, and by connecting the terminal disks with copper wire, and bringing those wires together, an electric spark was obtained. We all know, too, that it was with a battery of that kind that Sir Humphry Davy made known the elements potassium and sodium.

Robert Hare was in Philadelphia about the year 1807, although he was engaged every day in brewing, he was yet studying the scientific journals, and read of that marvelous discovery of Sir Humphry Davy. He constructed a volta pile, and realizing its shortcomings, began to experiment, and wrote to his dear friend, Silliman, in New Haven, about the experiment. In 1820 he came forth with a new instrument, which he designated the "calorimotor." After a while, I am going to show you a few pictures, first the picture of Robert Hare, himself, and then a picture of the so-called "hydrostatic balance," a very primitive form of apparatus, by which he burned oxygen and hydrogen together; and then a picture of the calorimotor, which consisted of nothing more than large coils of copper and zinc, one within the other, and these immersed in an acid. Hare believed, at that time, that what we call galvanic electricity was really electricity plus heat and that the calorimotor set in motion heat.

You engineers know Planté's battery, don't you? Well, Planté got the idea for his battery from Robert Hare's calorimotor. Examine the two and you can see the kinship. Of course, the Planté battery of to-day is modern, and is more efficient, but its beginning was the calorimotor, and then following on the heels of the calorimotor, came the deflagrator. The current from the deflagrator, when it passed over carbon points, caused the carbon to burn brilliantly—our first electric arc—with such intensity of light that Hare was blinded, and could not read for more than two weeks.

Over in England about that time worked another very interesting character, Michael Faraday, deeply interested in electricity. There is not much that we do not owe to him. He was not happy with the old Volta cell, and so he took to experimenting to get something that met his needs. He got it, and was happy, but, in casting about, he found that he had been preceded by Robert Hare, and said of the deflagrator that it was the most remarkable source of electricity that he had ever seen. He ascribes every credit to Hare. This was a tribute—

a great tribute—and it was made to a young Philadelphian who occupied himself with the physical sciences in the early part of the Nineteenth Century.

The pictures of those two instruments I am going to show to you, and, if I had the time, I could tell you a great many things which were done with those instruments, by Robert Hare. Perhaps some of you, now that you have heard of the calorimotor and deflagrator, would like to look them up. If so, you can find them in Hare's old book, called "The Compendium of Chemistry." You can find it at Leary's. Look at the illustrations showing those two pieces of apparatus, and read what the good doctor wrote he was able to do, particularly with the deflagrator.

Let us leave that paragraph, and turn to the third paragraph in the life history of this man, so far as chemical research is concerned. To-day we are familiar with the Elliott and other forms of gas apparatus. We think highly of them, but Robert Hare antedated these men. The principle that we admire in the modern forms of gas apparatus, especially those used for the analysis of mixtures of gases, we find in the Eudiometers made by Robert Hare. He speaks of gas analysis as Eudiometrical Analysis. I wish you could all be as interested as I am in this man and in his work.

I have referred you to Hare's Compendium because that is probably the one source from which you can get an idea of his work; his old papers are so scarce that they have been cast aside and lost, but that old book is the first, the most original text-book of chemistry written in this country—it did not appear first as the Compendium but as "Minutes of Chemistry," and in 1824 the first edition came out as the Compendium, and then it ran through four editions.

There is great danger that I may tarry too long on these things, but I am referring to them for the sake of those who are chemists and engineers, and who care to know something about the history of gas analysis. We speak of Bunsen as the father of gas analysis, and we refer to his "Gasometrische Methoden" as the original of books on gas analysis, but Bunsen was born in 1811, and Hare was busy with gas analyses in 1820, so that it is hardly likely that Hare learned this art from the Germans. No, he learned it from himself, and possibly from Volta, and I want to show you a picture of the very primitive form of Eudiometer, which gradually developed in his hands, until Silliman wrote a letter, in which he said, "Hare performs analyses before classes of students, making them with the greatest of accuracy, so that the student body sitting before him can see for themselves the whole operation, and the accuracy of the procedure."

Now, to the next paragraph in the research life of Robert Hare. I do not know just how to begin it. You have read about electric furnaces; you have read about the great work going on at Niagara Falls where, as you know, we have an abundance of electricity that we can

apply to all sorts of purposes, and many of you have read how caustic is made up there from common salt. Salt is electrolyzed and sodium passes into a mercury cathode, and the amalgam is washed out and decomposed, and caustic results. Well, ladies and gentlemen, mercury as a cathode in the electrolysis of aqueous salt solutions was first used by Robert Hare. And what did he electrolyze? He electrolyzed a solution of ordinary chloride of lime, dissolved in water—calcium chloride—what did he get? Well, at the cathode, he got an amalgam, and at the anode, there was an abundance of chlorine. Now, I want you to bear in mind when you go up to Niagara Falls and see them making caustic, and they show you one of those cradles, the bottom of which is covered with quicksilver, and tell you the chemistry that is going on there—bear in mind that that use of quicksilver or mercury as cathode was first introduced by Robert Hare, a fellow citizen and son of this town.

Let us go on further. To-day we hear of electroanalysis and the use of mercury as a cathode to receive metals, to effect separations, and do a lot of things which the chemist is grateful for,—and who was the person to use mercury as a cathode, in what is called electroanalysis? Wolcott Gibbs, afterwards Professor at Harvard. How did he happen to use it? When in 1841 and 1842 Wolcott Gibbs came over from Columbia, he became a student of Robert Hare, and of course the old master talked with his associates about the things near at heart. In 1880 Wolcott Gibbs said to the chemical world, "I can throw copper, nickel, cobalt—I can even throw potassium or sodium into mercury." Where did he get the idea? Surely from the laboratory of Robert Hare. So that, in one sense, we can call Robert Hare the father of electrolysis. We give the credit to Wolcott Gibbs, but he must have borrowed his mercury cathode from Robert Hare.

Now, the next paragraph. I sometimes think that Robert Hare was the greatest electro-chemist that this country ever had, and I propose to show you a picture of the first electric furnace. Robert Hare, in 1839, took charcoal made from dogwood—fine charcoal—and in this furnace of his, which received its supply of electricity from his own generator, changed the charcoal to graphite, and traced characters on paper. He wrote to Silliman, just as one lover does to another, and told him: "I put electrodes of charcoal from dogwood in this furnace, and sent the current from the deflagrator"—I have forgotten the strength, but he mentions it—"and I got the charcoal changed over to plumbago, and I traced characters on paper," those are the words. And later, of course, he was satisfied that it was a conversion of that form of carbon into graphite or plumbago. The world did not pay any attention to it. Yet, as far as the patent office doctors went, when Atchison applied to them to protect him in his new discovery, they did not see whether there lived such a man as Hare, or whether he had ever played with an electric furnace, or even got anything in

the playing that was worth while. But it stands there in one of his old papers.

Now, all that I have told you came out of this City of Philadelphia. It is a wonderful city. I think we all ought to go on to the house-tops and boost it. So much that is good has been done in it. I cannot see a black spot in Philadelphia. Robert Hare was the father of the electric furnace. What else did he do in that furnace? Why, he set phosphorus free from calcium phosphate. To-day we set it free from it in the electric furnace; that is one way of getting it, but away back in 1839, '41, '42, this researcher of our city did that very thing, and further made calcium carbide in his electric furnace. He threw it in the water, when it gave what calcium carbide gives to-day—acetylene, a disagreeable-smelling gas. He didn't name the gas that had a disagreeable odor, but he had calcium carbide all right, and when it reacted with water, he got the acetylene. Those are just a few of the things which were done in the first half of the Nineteenth Century, by this earnest investigator. Hare was truly a chemical philosopher.

Some years ago, Professor Ira Remsen, of Johns Hopkins University, wrote two long papers on double halides. The chemists here will understand how interested we all were in what he had to say. We thought he had made a real contribution to science. When those papers came from the printers and fell in the hands of Wolcott Gibbs, who then lived at Newport, he wrote a letter to President Remsen and accompanied it with a copy of the "Compendium of Chemistry" by Robert Hare, requesting him to read a certain page. Dr. Remsen turned to the page and read. A year or so ago in Chicago, when they honored him with a medal for his research work, he said, "When I read those lines, I found that Robert Hare had preceded me in the way of solving the constitution of double halides, and expressed his views more beautifully than I had done."

Remsen did not write his papers until twenty years ago. I just throw this in as a bit of pure chemistry, in the support of what I said that Hare was a great chemical philosopher. He was also a physicist. He did a good many other things, but I did not bring any other slides than those which show the things I have been talking about, and so I had better not tell you of more, because I have one or two individuals, also Philadelphians, about whom I should like to say a word. I think, ladies and gentlemen, that, if we will take the pains to study the literature of our science, chemistry, or, for that matter, the literature of any science, we will find that America has done her share in the way of investigation and research. Of course she is not as old as the European countries. She had to go to war in 1776, again in 1812, and as Hare wrote Silliman at that time, "The war has broken up my brewery business. I have lost everything!" And then we went to war in the forties and again in the sixties, and in '98 and so on. We have had a new country to open up, and while we have been opening it up, some

of our men have been giving themselves to this important matter of research.

(Slides exhibited and explained, showing the hydrostatic balance, the calorimotor, the deflagrator, the Eudiometer, etc.)

I have not the time, and I suppose it is just as well, to tell you of the other Philadelphians who were prominent as researchers. For some reason or other they have been overlooked. One of the pupils of Doctor Hare was a man named Robert E. Rogers. There may be some in the audience who knew him. Why do I speak of him? To interest the chemists who are here to-night. It is just possible that some of them, at some period in their lives as chemists, determined carbon in the wet way, heating it with chromic acid.

All students of chemistry have read, in old books and the more modern ones, of the wet method of determining carbon, and I have often wondered who originated that method. It was Robert Rogers. Those of us who have been making organic preparations have learned that aldehyde may be produced by oxidizing alcohol with sulphuric acid and bichromate of potash. Who first made aldehyde in that way? Robert E. Rogers. He was an interesting character.

And now let me speak of another Philadelphian, born in 1823, who died in this city in 1897. I was living here in the nineties, in the eighties—in the seventies, and I have to confess that I never saw this man. I do not know whether anyone in this audience ever saw M. Carey Lea. Why do I speak of him? Because he was a real scientific investigator in the field of chemistry. His chemical researches are better known abroad than at home. I wrote an account of him a couple of years ago in a book entitled: "Chemistry in America," and I have a picture of him there (indicating). But where did I get the picture? I copied it from a German translation of his works. I did not get it in Philadelphia. I saw, advertised by one of the publishers of Germany, the works of M. Carey Lea on photo-chemistry, and in that I found a picture of him, and I had it copied. Yes, the Germans called our attention to the work of this man. The Germans say he is one of the greatest chemists that we have ever had. The world says he was probably a pioneer if not the leader of the pioneers in photo-chemistry, and one of the things which this excellent gentleman did was to show the scientific world that silver, as we know it—that is, the metal unadulterated—may exist in a form that looks like gold, and I am sorry that, in this light, you cannot see what I have said is true. One of my associates, Doctor Lukens, spent all last night—worked during the whole night—that he might let me have this yellow-colored silver. It is a peculiar form of silver. Under white light it has the color of gold, from which you would not be able to distinguish it, if you were ignorant of the things I am telling you, and if I showed you

this, you would at once say that it was gold (exhibiting a metallic plate). But it is not gold; it is yellow silver. M. Carey Lea showed how to get it. Here I can see one of the plates, when I look this way (indicating) across the plate, the gold color comes up. M. Carey Lea also showed us another form, for that matter two other forms of silver. In this light, we cannot see it, but if you will come on the stage, you will see that is a light blue—something like indigo, and the other is dark blue. These three modifications of silver, these three allotropic forms, were discovered by a Philadelphia chemist. Thousands of people no doubt passed him on the street, and little dreamed that he was a pioneer in the field of photo-chemistry. I jotted down before I left my office a few things which I want you to bear in mind, if you will. He showed that bromide and silver are sensitive to all the visible rays of the spectrum, and that the silver bromide and silver iodide together are more sensitive to both the green and red rays than either the bromide or the iodide separately; that there do not exist any rays with a special exciting or special continuing power; that all the color rays are capable both of commencing and continuing the impression on silver iodide and bromide. Chemists would do well to read the brochure that was printed in Germany, in Brunswick, I think it was, about twenty years ago or perhaps fifteen years ago, and see what part their countryman has played in the development of this interesting field.

I do not know whether I have done what the committee of the Club wanted me to do or not. It is a little difficult for one interested in a specialty to make his subject popular, and I would not have undertaken to appear before you if I had not had the burning desire to let you know Robert Hare and just a bit about Robert Rogers, and a very little more about M. Carey Lea, true chemical investigators, fathers of chemical research in the City of Brotherly Love. When you hear anyone at table say to you, it is a pity that Philadelphia never originated anything in science, call up some of these facts. I listened to a New Yorker not long ago say that very thing, and when I mentioned the name of Robert Hare, he said "who was he?" Well, that is natural, you know, and I told him one or two things, and he said he was not aware of the facts. It is always, you know, in our ignorance, that we are apt to condemn, but our city has played her part in chemical research, and she is doing it to-day. It would not be right for me to refer to the work of any living persons—all men connected with the science of chemistry in and about Philadelphia are making their contributions which command the respect of their colleagues, elsewhere, so we have every reason to be proud of them.

THE CHAIRMAN: I am sure that I voice the feeling of every one here, not only members of the Club, but visitors, in expressing to Doctor Smith, our hearty thanks for his very interesting presentation of this subject.

Initiation of Explosions*

By WALTER ARTHUR

WHEN the historian draws aside the veil which hides from our view the dim misty past, we catch a few glimpses here and there of man's early efforts to manufacture and use gunpowder. With the scanty knowledge of the properties of various chemicals involved, and the crude methods of manufacture, many things were accomplished; and a description of them is most fascinating to anyone interested in such lines of work.

Just when gunpowder was first known is a matter of the most vague conjecture, but its use was recorded many centuries ago. Its advent into the world brought most marvelous changes into political matters, and at present, playing the most important rôle in the greatest of all human activity. Accompanying the use of powder and explosives, and closely allied with their development, is another and most important problem,—the initiation of the burning or explosion. Powder and explosives afford us a convenient means of doing work, if the energy represented can be made use of at a desired moment and in manner perfectly safe to those using them. Also the character of the explosion is dependent upon the efficiency of the method of ignition. Hence the importance of the question of initiation.

Until quite recent times, black powders or kindred mixtures were the only explosives in use, the energy contained was liberated by the burning of the mixture. This required only the minutest flame to start the ignition, as the particles of the various components were extremely finely divided, and only a small amount of heat was sufficient to raise them to the ignition point. The method of ignition was to fill with powder a small opening which led into the powder chamber, and by means of flame or spark, ignite this powder train from the outside. This was the old method of the match-locks and flint-locks. Most of the old cannons we see in our parks and public places were of this type.

In 1799, Howard discovered the substance we know as mercury fulminate. Its ability to fire gunpowder gave rise about the year 1815 to the development of the percussion cap. This is the beginning of what might be termed internal ignition in contradistinction to the previous method which we may style external ignition.

The percussion cap may be briefly described as a

small metal capsule containing a small amount of mercury fulminate, or mercury fulminate mixture, or other mixture with similar properties. This was used by placing it over the end of a small tube which led to the powder chamber. When struck a sharp blow, the mixture detonated, giving rise to a considerable heat, thus igniting the powder. This method of ignition for firearms was in common use until very recent times and is occasionally seen to-day. The significance of this invention was as great as the discovery of gun cotton or smokeless powder. It made the ordinary firearms much more effective by relieving the gunner of any anxiety as to whether he had powder in his pan. It permitted of ready use and made the arm independent of the weather. The combining of the projectile, powder charge and priming charge into one cartridge, has made our breech-loading firearms and machine guns possible.

There are a number of methods of internal ignition, all of them very much alike. In some instances, as in light ammunition, where a cartridge case with a thin head can be used, the priming mixture is placed in the rim of the head. This rim being struck a sharp blow by the firing pin where it is desired to ignite the powder; hence the so-called "rim fire." In most instances the priming mixture is placed in a small cup and inserted in a chamber in the head of the cartridge case, the firing of the priming charge being done by crushing the priming mixture between the cup bottom and the anvil. Many manufacturers of such ammunition place the anvil in the cup, but others make the anvil a part of the cartridge case, the result of the explosion of the primer pellet being a flame of considerable length and intense heat. The primer cup being held securely in its chamber allows no escape of flame except through a vent into the powder charge.

The length and heat of the primer flame will determine very largely the character of explosion in the cartridge case. If the flame be short and the temperature not very high, only a portion of the powder may be burned before the projectile leaves the muzzle of the gun. This, of course, lowers the pressure behind the projectile; as a result, a lower velocity of the projectile is obtained. On the other hand, if the primer flame be long and the temperature high, all of the powder may be fired.

The number of mixtures proposed for use in per-

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cussion caps and primers is legion, some of which are as follows:

Per cent.	Per cent.
21.9 sulphur (flowers).	25 lead sulpho cyanide.
30.8 antimony sulphide.	17 antimony sulphide.
47.2 potassium chlorate.	5 trinitrotoluene.
35.01 ground glass.	51.2 potassium chlorate.
28.01 mercury fulminate.	25.5 antimony sulphide.
14.00 potassium chlorate.	8.9 sulphur (flowers).
1.97 shellac.	12.4 ground glass.
21.00 antimony sulphide.	2.0 shellac.
53 potassium chlorate.	

It will be seen that either potassium chlorate or mercury fulminate is to be found in all of them. Potassium chlorate with an easily oxidizable body determines to a large extent the length of flame, sensitiveness and general effectiveness of the primer.

In order to increase the sensitiveness of the primer, an abrasive, such as ground glass, is added. The glass, due to the sharp edges and hardness of its particles, cuts into the particles of fulminate or potassium chlorate, and assists in their breaking when the mixture is crushed under the firing pin; and, as the firing of the primer is a result of the breaking of the crystals of the potassium chlorate or fulminate, the sensitiveness is thus very much increased.

The difficulties encountered in the manufacture and loading of primer mixtures are many. Owing to the extreme sensitiveness of such mixtures to friction or blows, they are usually mixed in the wet condition, and dried after loading into the caps.

In order to secure perfectly uniform results, it is necessary to have a thorough mixture of the various components. In using such materials as potassium chlorate, antimony sulphide, a great deal of difficulty is encountered in getting the proper granulation. Very coarse materials, about 100 mesh, give very poor results. The flame is short and the sensitiveness is poor. The best results come from materials of about 200 mesh. The sensitiveness and the flame length are good. The difficulty in using such fine mixtures comes in the mixing. These excessively fine materials are very difficult to mix thoroughly, owing to the tendency to collect in small pellets which resist the usual mixing. One of these very small pellets is often sufficient to cause a misfire if it gets into the primer cups.

Another difficulty, comparatively simple in its nature, yet disastrous in its results, comes from overloading the cups. Each cup is designed to hold a certain charge. Sometimes in careless filling, the maximum charge is exceeded. The anvil is forced in under great pressure, the result being that the pellet of priming material is so hard, the firing pin cannot break it; the result is a misfire.

We shall turn now to another class of explosives which require the use of a primer to liberate their energy. In the year 1864 Alfred Nobel, a Swedish engineer, used mercury fulminate for the purpose of filling priming

caps to initiate the explosion of nitroglycerine and dynamite. This discovery forms one of the greatest advances of the last century—an advance to which we owe the development of the whole modern technic of explosives, and such giant accomplishments as the building of the Panama Canal. Although discovered some twenty years previous, it remained but little more than a scientific curiosity until a convenient detonator was devised. These detonators, or dynamite caps, are of two types—that which is fired by burning of a slow fuze, and that fired electrically. They consist of small copper capsules partially filled with mercury fulminate, or a mixture of mercury fulminate and potassium chlorate. The detonating cap to be fired by a slow fuze is exactly as described above; the fulminate being fired by the burning powder at the end of the fuze. The detonating caps fired electrically are as just described, except immediately above the charge of mercury fulminate is a small charge of gun cotton which is fired by the heat from a short resistance wire. The electric current necessary for such work depends upon the number of charges to be fired. These detonators are made up in various sizes and strengths, and are numbered from 1 to 10.

Designation No....	1	2	3	4	5	6	7	8	9	10
Charge in grams..	.3	.4	.54	6.5	.8	1.0	1.5	2.0	2.5	3.0

By the use of electric detonators, a great many charges may be fired simultaneously, thus accomplishing what would otherwise be impossible. This method also allows all persons to retire to a safe distance before the explosion occurs. It also affords a means of detonating quantities of nitroglycerine deep down in the earth, as in oil well shooting.

Recently a great part of the mercury fulminate in these detonators has been replaced by picric acid, trinitrotoluene, or tetranitromethylamine. The strong initial effect is thereby increased; in this way 0.5 g. of mercury fulminate has been made to detonate a charge which required 3.0 g. of mercury fulminate in the earlier caps.

The use of priming substances for high explosives in modern warfare is at present of much interest. The methods of application are much the same as in commercial explosives, the only difference being in the use of a time element in many cases. The initial primers are provided with firing pins which are actuated either by the sudden movement of the projectile in the gun or by the striking of the shell against some resisting body. Since the space in high explosive shells through which a firing pin might move is quite limited, a very sensitive priming mixture is used. Mixtures of mercury fulminate, potassium chlorate, a strong reducing agent, and often an abrasive, such as ground glass, are used. In order to protect these primers against abrasion and atmospheric agencies, shields or caps of paper or metal are provided. The whole of it must be so arranged that a light blow of the firing pin measuring only a few inch-

ounces will suffice to bring about the necessary explosion of the primer. The explosion of the primer detonates a greater charge of mercury fulminate which communicates its detonating influence to the body of the main explosive. Quite often a booster charge is added between the fulminate and the explosive, and in this way the detonating action is built up.

In armor-piercing shells it is desirable that the explosion take place after the shell has penetrated the armor. In this case the action is such that the primer is fired as a result of impact of the shell against the armor plate; this in turn igniting a train of powder so arranged that the main detonating mass will be exploded at the correct moment. Owing to the fact that these shells travel at a great velocity, only the briefest delay is required between the action of the primer and the detonator.

In high explosive shells where the entire action is to be instantaneous, the delay action is omitted, the explosion of the priming charge, detonator and boosting charge taking place in most rapid succession.

In the case of shrapnel shells where an adjustable time action is required, movable trains of powder are interposed between the primer and the main charge, the primer being fired from the set-back in the gun. Shells of this type are often provided with two primers—one to be used with the time action, another one to function on impact.

There are various types of cannon primers which we can not discuss at this time; most of them differ from the small arms' primers in size and mechanical details. Some of them are exploded by friction instead of a blow.

Some of the difficulties encountered in the manufacture of the various primer mixtures might be of interest at this time. The first thing that naturally attracts attention is the mixing of these compositions, as they must be sensitive to blow and friction. The handling and loading is attended with much danger. As the presence of some liquid in the mixture acts as a sort of cushion between the various particles, these mixtures are usually made up with water or alcohol. After the mixture has been put into place, the liquid is dried out. Some firms handle these mixtures dry, but it is always attended by considerable danger—even in the wet condition, the mixing must or should be done by hand. Great care must be exercised during the mixing lest some portion become too dry and the friction from the rubbing start an explosion. The mixing tables and the rooms must be kept thoroughly clean.

Attendant upon the danger from explosion is the danger from poisoning when mercury fulminate is used in the mixture or loaded separately. Not only is mercury fulminate a poison when taken internally, but the dust from it produces dermatitis and skin eruptions.

The degree of fineness in granulation of the materials is a large factor in the manufacture of primers. If the materials be very fine, difficulty is experienced in thor-

ough mixing. If they be too coarse, the primers made therefrom are not sensitive and do not burn freely or incompletely, and give poor ignition. In the case of small arms primers, this produces low velocities due to the fact that a portion of the powder may fail to burn before it is thrown from the gun.

In the manufacture of small arms primers, it not infrequently happens that an excessive amount of the mixture is loaded into the cup, and when the anvil is forced down, this produces a pellet so firm and resistant that the ordinary blow from a firing pin can not break it, and a misfire is the result.

It is interesting to note that the function of artillery primers made with a shallow layer of a friction mixture backed by mercury fulminate is dependent upon the character of the blow. If a light blow is delivered, the fulminate only burns; if a severe blow is delivered the fulminate is exploded. The character of the point of the firing pin has a great deal to do with the sensitiveness of primers of this type. If a blunt point be used a much heavier blow is required than if a sharp firing pin be used. If a long taper point be used much less disturbance of the mixture is produced than if a short taper point be used. A round point also gives less disturbance to the mixture than a triangular or a square point. The maximum effect should be produced by a short taper sharp square point.

The question has often arisen, "Why does a mixture of potassium chlorate and some easily oxidizable agent explode when struck a sharp blow?" This is not easily answered. The exploding depends, of course, upon the fact that crystals of potassium chlorate are broken or fractured in the presence of some substance that unites with the oxygen very readily. If a substance, like red phosphorus, be in contact with the broken crystals, an explosion of great brisance occurs. If some substance like sulphur, which unites with oxygen much less readily, is present, an explosion occurs which is less active and the report therefrom is much less dull. In fact, potassium chlorate and red phosphorus are so active that they can scarcely be mixed without an explosion, while potassium chlorate and sulphur will admit of quite considerable mixing. If potassium chlorate and sugar be mixed, we get merely a burning—so slow is the exchange of oxygen.

We may picture in our minds a crystal of potassium chlorate as made up of centres called potassium, chlorine and oxygen, all arranged in some perfectly definite manner and held together by lines of force of some kind. When a crystal is broken some of these lines of force between the oxygen and the other elements are severed, and for the moment are free. If phosphorus be present, which is always on the lookout for its friend oxygen, it immediately seizes upon the opportunity to add another member to its household. The warmth of friendship produces sufficient heat to warm up the neighboring oxygen communities to a state of activity, hence heat, flame and general rearrangement of affairs.

The question is asked, "What happens when a crystal is broken when no phosphorus or oxidizable substance is present?" Of course, this question cannot be answered at present; our knowledge of the molecular arrangement is too scanty. If crystals of mercury fulminate and a few other substances be broken rather quickly when unattended by an oxidizing substance, a most severe explosion occurs. But why? This is just as difficult as the other questions. The answer may be made that crystals of mercury fulminate are unstable. This explains nothing. Perhaps some of the recent work of the Bragg's in crystal structure may eventually give us some information.

The question has often been asked: "What properties of mercury fulminate enable it to act as a detonator, and in what way is the primary explosion related to the principal explosion. The chief characteristic of mercury fulminate which makes it valuable as a detonating agent is the care with which it can be exploded by simple and ordinary means and the wonderful pressure developed therefrom, which brings about the explosive decomposition of the explosive mass. A large number of chemicals are violent explosives and many exceed mercury fulminate in explosive power but are less suitable or are not suitable at all as detonators. Some are too sensitive to shock or friction; some are too insensitive. Some may cause the explosive wave in the main explosive mass to proceed too slowly. Mercury fulminate occupies the middle position. A great number of investigators have attempted to account for the initiating effect of detonating compounds. Abel advanced the theory of synchronism of molecular vibrations between the primary and secondary explosives. This theory is supported by the fact that many substances, as diazo-benzene nitrate and nitrogen chloride, could be used only in large quantities, if at all, as a detonator of explosives. While mercury fulminate in small quantities was sufficient to produce a detonation, Abel ascribed this exceptional behavior to a resonance phenomenon, which he described as a molecular vibration which brought the molecules of the explosive to be detonated into a synchronous vibration, thence to detonation. L. Wöhler made a thorough investigation of the Abel theory and came to the conclusion that it was not sufficient to account for the phenomenon. No theory advanced so far seems wholly satisfactory.

It was found by Abel that the most violent exploding compounds, nitrogen chloride and iodide, are practically without detonating action on nitroglycerine and gun cotton. Only once could he cause detonating action with 3.25 g. of nitrogen chloride, while 0.32 g. of mercury fulminate was sufficient to produce the detonating action. This remarkable difference is explained by Wöhler, by the enormous pressure which mercury fulminate shows in contrast to that of nitrogen chloride, and in addition, calls attention to the fact that, although the gases evolved by the explosion of the two compounds are very nearly equal, the heats evolved are only 312

calories per kilo for nitrogen chloride as against 411 calories for mercury fulminate. Wöhler attaches the greatest significance to the fact that the loading density of mercury fulminate is far beyond that of nitrogen chloride.

In spite of the fact that nitrogen chloride has a smaller calorie number and a lower loading density, it is likely that nitrogen chloride produces a greater instantaneous pressure than mercury fulminate. Judging from the shattering effects produced upon glass and similar bodies, nitrogen chloride greatly exceeds mercury fulminate in brisance. If we take into consideration the difference in loading density and heat evolved, we find that difference is not sufficient to account for the ten-fold difference in effect.

It is common practice to manufacture detonators which are intended for explosives that are brought to explosion with difficulty, with a booster charge of a like or similar substance, such as trinitrotoluene or tetranitro-methyl-aniline. This supports Abel's theory rather than opposes it.

In the year 1883 Bertholet offered the theory that the detonation of a brisant explosive was to be considered as a sudden wave-like decomposition, propagating through the whole mass, brought about by the kinetic energy of the detonator. According to modern views, however, neither the pressure as such, nor the violent changes brought about by it, is sufficient to account for the detonating waves of a secondary explosive. Another author of recent date agrees with this view that it is the adiabatic heating of the medium in contact with the priming substance, caused by the great pressure which initiates the exceedingly high velocity of the detonating waves.

The action of a blow of a hammer is often explained upon the assumption that the heat, into which the energy of the hammer is transformed on being suddenly brought to rest, heats the portion of the explosive struck to a temperature at which a sudden increase of the velocity of decomposition leads to an explosive velocity. It is quite well known that very sudden heating of an explosive leads to an explosion.

How then can the detonation of an explosive be carried over an intervening air space? The thermal hypothesis will not account for this. This is explained by the compression and rarefaction of the surrounding air. Since the force of such waves decreases as the square of the distance, this theory is not sufficient. From what has been said, it can be seen to be a very complex subject, and how many theories fall when all the facts are taken into consideration.

For many years mercury fulminate has held its place as a detonating substance as superior to all others. Of recent years, however, its place has been threatened by other compounds which bid fair to displace it. One of the most promising of these is lead azide; lead azide is

a salt of hydronitric acid whose constitution is expressed thus: $\begin{array}{c} \text{N} \\ \diagup \quad \diagdown \\ \text{H} \end{array} \text{NH}$. Some investigators unite it, thus: $\text{N} = \text{N} = \text{N} - \text{H}$. This acid forms a great number of salts, as mercury azide, silver azide and sodium azide.

The heavy azides, as lead azide, are prepared by treating a solution of sodium azide with a soluble metallic salt, such as lead acetate, the sodium azide being prepared from nitrous oxide and sodium amide.

Large crystals of lead azide and mercuric azide have been found to be very sensitive to mechanical shock; the sensitiveness increasing with the size of the crystals. Even the breaking of a single large crystal is said to bring about explosion. Crystals as large as 3 mm. in length, when dry, often explode when brushed with a feather. If a hot saturated solution be allowed to slowly cool, large crystals sometimes form, which detonate under water. The formation of such crystals must be avoided. This property is scarcely obtainable with the fulminates.

Mercury fulminate and lead azide differ very greatly in flash point—lead azide flashing at about 330° , mercury fulminate flashing at about 180° .

Lead azide in fine crystals appears to be less sensitive to blow than mercury fulminate. It is very stable when stored at high temperatures, such as 50°C .; it is, however, decomposed by strong sunlight. The action of lead azide upon metals is slight, while fulminate is quite active.

Mercury fulminate may be dead pressed, while lead azide increases its brisance and explosive power with pressure. If detonator caps be loaded with lead azide and a booster charge, much less lead azide is necessary to produce the desired detonation. The sensitiveness of fulminate to mechanical shock is much lessened by the presence of as much as 1 per cent. moisture, while lead azide is much lessened by this small amount. This particular property is extremely valuable in case of storage of detonating caps in humid atmosphere.

Many other substances have been proposed as detonating agents. Trinitro-resorcine or lead styphnate ($\text{C}_6\text{H}(\text{NO}_2)_3\text{O}_2\text{Pb}$) has been found to be an excellent explosive. Hexa-methylene triper-oxide-diamine ($\text{N}(\text{CH}_2\text{O.OCH}_2)_3\text{N}$) is said to exceed mercury fulminate 4 or 5 times in priming power.

A number of others may be mentioned as:

Nitrogen-tetra-sulphide, N_4S_4

Diazo-benzol-nitrate, $\text{C}_6\text{H}_5-\text{N}_2\text{NO}_3$

Basic mercury nitro-methane, $\begin{array}{c} \text{O} \\ \diagup \quad \diagdown \\ \text{NO}=\text{C} \quad \text{O}-\text{Hg} \\ \diagdown \quad \diagup \\ \text{Hg} \quad \text{O} \\ \diagup \quad \diagdown \\ \text{NO}=\text{C} \quad \text{O}-\text{Hg} \\ \diagdown \quad \diagup \\ \text{O} \end{array}$

Perchlorate of tri-mercur-aldehyde, $\text{ClO}_4\text{Hg}(\text{Hg}_2\text{O}=\text{I COH})$

Positions Vacant

Those in need of competent and experienced men will find it to their advantage to make their wants known through these columns. The Secretary of the Engineers' Club is constantly in touch with men capable of filling positions in all branches of Engineering. No charge is made for this service.

Engineer skilled in handling of materials, having had experience with conveying machinery and other mechanical means of handling and transporting materials, to study the handling of materials at plants of large industrial corporation. Apply Engineers' Club, No. 128—A.

Heating and ventilating engineer to study heating and ventilation and various similar problems at plants of large industrial corporation. Apply Engineers' Club, No. 129—A.

Combustion engineer to study combustion and boiler efficiency at plants burning bituminous and anthracite coal, plants ranging in size from 200 to 75,000 h.p. Apply Engineers' Club, No. 130—A.

Mechanical engineer who has had several years' mechanical experience, preferably in chemical industries, to investigate

mechanical problems arising in the operations of a large industrial concern. Apply Engineers' Club, No. 131—A.

Young man wanted to sell mechanical appliances; 1915 or 1916 technical graduate with sales experience in mechanical lines, for work in Philadelphia and vicinity. Good opening for aggressive man, salary commensurate with ability. Apply 132-A, Engineers' Club.

Engineer absent from office most of the year, wants to sub-rent one room of office suite in large office building very centrally located. Party can have use of the entire office for the period the engineer is absent. Employs stenographer. A very attractive arrangement will be made with a responsible party. Apply Engineers' Club No. 1-C.



AMERICAN SOCIETY OF MECHANICAL ENGINEERS .: PHILADELPHIA SECTION

EMMETT B. CARTER, Chairman

W. R. JONES, Secretary, Eng. Dept., Univ. of Penn.



March 15, 1917—Joint Meeting with Franklin Institute, to be held at *Franklin Institute*. The paper of the evening, "DESIGN, CONSTRUCTION, AND EQUIPMENT OF A MODERN MILITARY AEROPLANE," will be presented by MR. J. C. HUNSAKER. March 27, 1917—Joint Meeting with the American Society Heating and Ventilating Engineers, to be held at the *Engineers' Club*. The paper of the evening, "DISTRICT HEATING" will be presented by MR. WALTER J. KLINE, of the American District Steam Company.

PROFESSOR CATHCART ON THE NAVY

OUR members will recall with a great deal of pleasure the meeting in the early fall at which Professor W. L. Cathcart delivered his timely paper, "The Development of Our Fleet and Naval Stations." Subsequently the same paper was given before the Society at its New York meeting. Published in the February issue of the *American Society of Mechanical Engineers' Journal*, it has attracted wide attention.

It undoubtedly forms one of the clearest and best treatments of the subject that has been given. Appearing as it does at a time when every scrap of information regarding our navy and its problems is eagerly read, it should be a source of gratification to us that it comes from the Philadelphia membership.

Another meeting in the near future at which Professor Cathcart would talk on his favorite topic would not go amiss, and the Committee might do well to approach him with such an invitation.

ARRANGEMENT OF MEMBERSHIP LISTS

The Society's annual year book and list of members just come from press reminds us that the method used of listing is one of the most convenient and logical forms, namely of an alphabetical list irrespective of membership class and a geographical list similarly arranged.

It is a regrettable fact that many similar compilations are prepared without regard to the uses to which they are to be put. One at least of the four leading Engineering Societies issues a yearly list in which the membership is arranged by grades. The only possible convenience that such an arrangement can be is that the Home Office can bill with more expedition each list the amount of dues which apply. Such a list must be, of course, indexed in the back. If a person desires to know if John Smith is a member, and does not happen to think of the index,

he must look in each class of membership independently until he strikes John Smith's name.

It is a matter of congratulation that the Engineers' Club in its first membership list adopted almost the same scheme as the A. S. M. E. Obviously, the Engineers' Club does not need a geographical list.

FREE HAND DRAWING FOR THE ENGINEER

If there is a recognized Engineering School that requires courses in free hand drawing, perspective, etc., the writer is not aware of it. And yet who that has had any experience whatever in Engineering management, or salesmanship, can fail to notice that when making an explanation of some contrivance, condition, trouble or accident, he could add emphasis by a quick free hand perspective sketch. Nor can anyone who has watched an artist or "near artist" fail to be impressed with the quickness that he can dash a few pencil lines on paper and make them stand out as a real drawing. The very speed and ease of men with this training is most striking.

Years ago when the writer was at school he was required, with some others, to make a sketch of an indicator, starting out in the usual way with a sketching pad and a straight edge. The job took about two hours. The result certainly was not all that was to be desired. Beside him was a student who finished a free hand sketch of the instrument in about two minutes. A few bold lines had accomplished the result. It was artistic; it was plain; it had detail. Questioning elicited the fact that two years of free hand drawing had developed his ability to sketch rapidly and with good result.

Many good mechanics do not read drawings efficiently. A rough perspective drawing explains to them quickly. In discussing complicated drawing, the use of rough perspective sketches is most efficient.

Why then do not some of our Engineering Schools put a little emphasis on this subject? I believe the result would prove of untold value to the students.



ILLUMINATING ENGINEERING SOCIETY PHILADELPHIA SECTION

ROBERT B. ELY, Chairman

T. ELMER MOON, Secretary



The next meeting will be held Friday, March 16, 1917, at 8 P.M., at the Engineers' Club.
Subject: "INDIRECT LIGHTING DESIGN," by G. H. Swanfeld. Also Dr. G. A. Hoadley will continue the presentation of the I. E. S. Popular lecture on the Fundamentals of Illuminating Engineering.

The Regular Monthly Meeting, Philadelphia Section, Illuminating Engineering Society, was held at the Engineers' Club, 1317 Spruce Street, on Friday evening, February 16, 1917.

The speaker of the evening was Mr. L. C. Porter, of Harrison, N. J., who presented a paper on the subject of "Flood Lighting," amply illustrated by lantern slides.

Preceding the reading of the paper, Mr. F. H. Gilpin continued the 20 minutes' talk on the "Fundamentals of Illumination" with the discussion of "Illumination" and "Brightness." Both parts of the meeting were fully discussed.

Following the meeting, at 10.15 P.M., the members and their friends visited the City Hall of Philadelphia to inspect the flood lighting equipment of the tower.

FLOOD LIGHTING

BY L. C. PORTER

(ABSTRACT)

THE projection of a flood of light on to a distant object is nothing new. In *Leisure Hour* for 1872 under the head "Public Illuminations," the suggestion is made to illuminate St. Paul's dome by flooding it with light projected from various quarters: Since then individual spectacular installations have been made as instanced at Niagara Falls, Statue of Liberty, Singer Building tower, etc.

The general application of flood lighting, however, is of very recent origin. It has been made practical and economical by the perfecting of the concentrated filament incandescent lamp. It is of particular advantage for the illumination of surfaces more or less inaccessible and those that would require expensive runs of wiring for other methods. The original experimental installation was on the water tank of the Driver-Harris Wire Co. in Harrison, N. J., from which all other schemes were developed. Since that time it has been adapted for lighting, for other than publicity work, construction work, patrols around munition plants, prisons, military camps, bowling alleys, rifle ranges, drill halls, arsenals, trap shooting fields, logging camps, freight piers, advertising banners, flags, statues, clock towers, fountains, stained glass windows, ice ponds, steam shovel and dredging operations and many forms of outdoor game fields.

The flood light unit, essentially a projector, is akin to the "search" light and their fields overlap.

The adaptation of the focus type filament lamp projector to a search light beam (with suitable accessories) makes available many types of "search" lights for small power boats and signalling lamps and tubes of all types. Many of the U. S. Coast Guard stations are now equipped with portable battery equipments having a range of fifty miles, as well as range lights and harbor lights.

The primary function of a flood light is to project illumination to a distance. There are two methods of doing this, in common use: One by passing the light generated through a lens and thus concentrating the rays into a beam; the other by reflecting the light rays by use of a reflector of parabolic shape, which accomplishes the same result. With either equipment, if the light could all originate from a point source (a physical impossibility) located at the focal point of a perfect lens or reflector, the resulting beam would be parallel and, neglecting atmospheric absorption, would reach to infinity. However, all light sources have physical dimensions, and hence the beam from such a source used with a projecting lens or reflector will have a certain amount of spread, depending on the size of the light source, the focal length of the projector, etc. Its intensity is assumed to vary inversely as the square of the distance from the projector.

The size of the light source, however, has a very material effect upon the spread of the beam and, therefore, also upon its intensity. For, assuming that we have the same volume of light to work with, it is obvious that if it is spread out over a large area, as with a beam of large dispersion, the light intensity on this area must be lower than if all of the light were confined to a small area by projecting it as a narrow beam. Thus, the source of light has great influence on the resultant beam. Having a certain light source to work with, the resultant beam when this source is used in a projector, will also depend somewhat upon the size and design of the lens or reflector used, and also on the accuracy with which the light source is located at the exact focal point. In general it might be said that a glass lens or glass mirror can be ground and polished more accurately than a metal mirror can be spun; hence, where extremely power-

ful beams are required, such as in navy searchlights, or where a little "spill" or stray light is objectionable, such as in stereopticon work, the glass lens or mirror is usually used. For flood light service, however, neither extremely powerful beams nor ones with no stray light are desirable. For this reason metal reflectors are most common in this service.

Metal reflectors may be made of polished aluminum, having a reflection coefficient of about 61 per cent.; or of brass, nickel-plated, with a reflection coefficient of about 54 per cent.; or of brass, silver-plated, producing a surface with 86 per cent. reflection. The aluminum reflectors have the advantage that they can be buffed up an indefinite number of times, whereas the plating on the others gradually wears off with frequent polishing. Replating, however, is not a very serious problem, and many silver-plated reflectors are in service. The reason for the nickel surface is that it does not corrode or tarnish quite so rapidly as silver.

Flood light reflectors are parabolic in shape, but vary as to depth and focal length. With a given diameter a short focus parabola will utilize more of the total light flux from a source than a long focus parabola. Where incandescent lamps are used as a light source, care must be taken not to use so short a focus reflector that the lamp bulb will strike the reflector and prevent the filament coming into the focus. As focus-type incandescent lamps are generally made in round bulbs with the filament in the centre of the bulb, we can state that the focal length of the reflector should not be less than half the diameter of the lamp bulb, plus a small clearance space of, say, $\frac{1}{4}$ inch.

The importance of careful focusing may be shown by the following data on a 16" diam. 3" focus reflector.

Location of filament	Beam candle power
At focus	220,000
$\frac{1}{16}$ " back of focus.....	70,000
$\frac{3}{16}$ " back of focus.....	40,000
$\frac{5}{16}$ " back of focus.....	18,000
$\frac{7}{16}$ " back of focus.....	8,000

Moving the filament $\frac{1}{4}$ " to the side, threw the centre of the beam 4 ft. to one side and reduced its c.p. from 220,000 to 125,000.

The dimensions of the light source also have an important influence on the beam c.p. Using 6 100 watt lamps of different types the beam c.p. of one projector varied from 462,000 to 3,800.

Most projection devices are equipped with means of moving the source so that it may be correctly focused. Improperly adjusted automobile headlights are today one of the greatest causes of complaint in regard to glare.

One of the special advantages of flood lighting is its simplicity. The whole equipment is so simple that no expert is needed to install it.

The question of location of projectors is largely one of judgment. A few minutes' experimenting will quickly demonstrate the most satisfactory location. In flood

lighting, it is well to choose at least two locations—one diagonally off from each end of a surface to be lighted. Thus, the light falling on the surface from two different angles will tend to minimize shadows, which might be thrown by protrusions, such as windowledges, cornices, pillars, etc., which would occur if the light all came from one location. Where possible, it is well to avoid projecting the light directly, *i.e.*, perpendicularly at a surface, as it tends to produce spots of light rather than even illumination.

Having the light come at angles from two or more locations also tends toward more even illumination. It is well, where practical, to arrange units so that no one part of the surface illuminated is entirely dependent on one projector. It is quite common practice in lighting a surface to cross the beam, *i.e.*, have the projectors at one location light the portion of the surface farthest from them, and similarly at other locations.

In lighting a building facing on a street, care should be taken to mount the projectors high enough, or so train their beams as to prevent them from shining on the eyes of pedestrians, drivers, etc., as glare might result in serious accident. For this reason buildings are frequently not flooded below a point 15 feet above the street level. It is well, where possible, to locate the projectors in such positions that they will not be visible from the street.

The question of intensity necessary and wattage is one which depends largely upon local conditions. If the surface to be lighted is very light color and seen against a dark background, it may be practical to use as low as $\frac{1}{4}$ -watt per sq. ft. of surface lighted. Light gray buildings, such as granite and marble, may be well lighted in average city surroundings with an energy expenditure of one watt per sq. ft. of surface lighted. The darker surfaces, such as red brick and light sand stone, do not appear so well flood lighted. Red brick requires at least 2 watts per sq. ft., while dark red, dark green and bronze surfaces may require as high as 5 watts per sq. ft. Expressed as surface intensity, the average requirements are 2 to 10 foot candles, depending upon local conditions.

Given a surface to flood light, the procedure is first, to find the available locations for flood lighting projectors and the distances and angles from the area to be lighted. Next, determine the area to be lighted and estimate (as above) the total wattage necessary. This divided by the wattage of the lamp to be used will give the number of projectors required. If this figure is fractional (one-half or over) always use an extra projector. The beam from a projector striking squarely on the surface at right angles to the axis of the beam illuminates a circle; while striking at an angle the area lighted is an ellipse whose length and width depend upon the distance to the projector and the angle between the surface and the axis of the beam.

The exact direction in which to train each projector and the spread of the beam can be worked out on paper

(Continued on page 150)



PHILADELPHIA ASSOCIATION OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

SAMUEL T. WAGNER, President

C. W. THORN, Secretary



MORE COMMENT ON THE CIRCULAR INQUIRY OF THE COMMITTEE ON ENGINEERING EDUCATION

In a previous issue of the Club Bulletin, one of our members took issue with the basis of the postal card inquiry which had then just been addressed to the members of the several national engineering societies, requesting the judgment of each member as to the relative ranking of six groups of qualities in the mental equipment of an engineer. The point was raised that a serious reply was hardly possible (though the temptation to make a superficial reply was strong), because of the indefiniteness of the problem stated. The appearance of the report of this committee has brought out a more detailed protest from Mr. Halbert P. Gillette, in the issue of *Engineering and Contracting* for January 31st, which many members of our local association would be apt not to find unless called to their attention; and as it is an interesting discussion of a matter which has been officially before our Society, we think it worth while to reproduce Mr. Gillette's remarks in full.

Illogical Methods of Rating Human Qualities in Selecting Men, or Accounting for Relative Success

BY HALBERT P. GILLETTE

Name in order of importance the following six organs:
Heart, lungs, intestines, liver, kidneys, pancreas.

To put such a question would itself raise a question—a question as to the questioner's seriousness or his sanity. Yet if 10,000 men are asked to name the order of importance of certain mental faculties or qualities, there are few who will refrain from expressing an opinion off-hand. Thus, when the members of the national engineering societies were asked to rate the relative importance of six mental "qualities," almost 7,000 gave replies. It is my purpose briefly to question the rationality of answers to such questions. First, let us have the question that was put to these engineers by the Joint Committee on Engineering Education. It was:

Please prefix numbers to the groups of qualities listed below to show the order of importance that you give them in judging the reasons for engineering success or in sizing up young men for employment or promotion:

- Character, integrity, responsibility, resourcefulness, initiative.
- Judgment, common sense scientific attitude, perspective.
- Efficiency, thoroughness, accuracy, industry.
- Understanding of men, executive ability.
- Knowledge of the fundamentals of engineering science.
- Technique of practice and business.

In the November Bulletin of the Society for the Promotion of Engineering Education, C. R. Mann, of the Carnegie Foundation for the Advancement of Teaching, gives his deductions from the 5,441 answers to this question that were in regular form. He deduces the following rating:

	Per cent.
Character	24.0
Judgment	19.5
Efficiency	16.5
Understanding of men	15.0
Knowledge of fundamentals	15.0
Technique	10.0
Total	100.0

Mr. Mann says:

The fact that character is rated at 24 per cent. does not mean that an engineer can succeed with a 24 per cent. character. It does mean that even a perfect character is but 24 per cent. of the engineer's total equipment.

Does it? Where is it intimated in the original question that the qualities enumerated are all the qualities that should be embraced in an engineer's mental equipment? What of such qualities as imaginative power, strength of memory and courage? Are these of no consequence? And what of the scores of other qualities not embraced in the six headings given in the question? The omissions of many qualities should alone cause hesitation about answering the question put to the members of the engineering societies, but failure to define the qualities is an even greater reason for hesitancy.

Mental qualities are not easily defined in a philosophic way. Turn, for example, to Logic in the Encyclopædia Britannica and read the 10 definitions of judgment there given, together with the statement that all 10 are in error.

Note, furthermore, what a mixture of different qualities are embraced under the heading of "Character" in the question under discussion. Wherein is "integrity" related to "initiative"?

Note also that some of the qualities named under one of the six headings are but species of the same qualities given under another heading. Does not "executive ability," for example, consist in the exercise of "judgment"? As a matter of fact is not "judgment" a term that here signifies ability to reason correctly? If not, what is it? If so, wherein can "judgment" be segregated from the other mental qualities that involve the ability to infer or reason?

The mind is a complex whose various actions are classifiable, but this does not mean that the brain itself is susceptible of an analysis into parts or regions corresponding to all the classes of its actions. We may focus our attention on one class of mental action, but this is not

tantamount to saying that such a class of action can exist apart from other classes of action.

If those who propounded the question under discussion had defined each of the mental qualities, it is likely that they never would have sent it out to engineers for answer; for it is really unanswerable, as a whole, and only in part answerable by the assumption of conditions not stated in the question itself.

There is a fundamental principle of logic which, though not stated explicitly in books on logic, should be self-evident to any engineer or scientist.

When several causes interact in producing an effect, none of the causes can be assigned superior importance over any of the rest.

The question asked at the beginning of this article serves to illustrate this principle. Since human life is dependent on the six organs there named it is impossible to rate any one of the six organs as higher in importance than any of the rest. Similarly, since the professional success of an engineer is dependent on many mental qualities—inherited as well as developed by training—it is impracticable to assign any general order of importance to them. It is true, however, that for the performance of a definite function one or more of the mental qualities, if particularly pronounced, may lead its possessor to dominance. But the function to be performed must be named definitely before a question as to relative importance can be answered. Thus, if the function be that of original research in any engineering laboratory, two qualities, inventiveness and persistent thoroughness, are paramount. On the other hand, if the function be that of selecting and organizing a force of men, the quality called "executive ability" is paramount. Yet in answering the question under discussion only 2 per cent. of the engineers drew any distinction between "judging the reasons for engineering success"—which is often largely a matter of executive ability or skill in self-advertising—and "sizing up men for employment," which is usually a radically different matter.

Let us now approach the question under consideration from a different avenue. Let us apply another principle of logic:

No two things can be quantitatively compared or rated except in terms of a common unit of measure applicable to both.

Applying this generalization to the question under discussion, what is the common unit of measure applicable, say, to "integrity" and to "technique of practice"? What unit of measure is common to "resourcefulness" and to "accuracy"?

No one would be likely to attempt to compare quantitatively a rose with a star, except in two respects—mass and dimensions—for these are the only two kinds of units known to be applicable to both. Yet few engineers could resist the invitation to name "the order of importance"

of mental qualities that have no common measure, save perhaps that connoted in the vague word "success." If we interpret "success" to mean profit, there are several sorts of profit—profit to the individual, profit to his employer, profit to the society in which he lives, profit to society in general. In brief we must define our unit or standard of measure before we can "rate" any two things, and we must be sure that the same unit is applicable to both.

Suppose a body of engineers were asked this question: Can you name the order of importance of a pine tree and a prune? If the question were taken seriously, what engineer would fail to ask: Importance in what respect? In relative size? In amount of carbon available for fuel? In quantity of nutritive matter? To a hungry man a prune is more important than a forest of pines. To a freezing man, a limb from a pine is more important than a carload of prunes.

It would seem that most of the engineers to whom the question under discussion was submitted would either have demanded, or themselves have stated, the common unit of measure. That they did not do so is apparently good evidence that few of them had studied logic. Isn't there much significance in the fact that not a single book on logic is to be found in the libraries of the four national engineering societies? Logic is presumed to be the science of reasoning—the science of sciences—and engineering is the application of science, not one science, but all science. Something is wrong either with logic as it is taught, or with engineering as it is ordinarily taught, or with both. I am inclined to think that neither logic nor engineering is commonly taught well.

Words that have meaning are merely symbols of energy or the three quantitative categories of energy—mass, distance, time. Words are tools that facilitate reasoning, provided their true significance in terms of energy is understood; but when the energy significance is not understood, words are a positive hindrance to reasoning, leading frequently to the most absurd conclusions. As exemplifying the truth of the latter part of the last sentence, consider the absurdity of the conclusion reached by Mr. Mann, namely, that "even a perfect character is but 24 per cent. of the engineer's total equipment." Starting with words that were not defined, formulating a question that does not accord with two fundamental principles of logic, collecting answers from 7,000 engineers, applying mathematics to the answers, we get what? Pure nonsense, yet a sort of nonsense that parades as science.

I will not now discuss another underlying fallacy in this whole procedure, namely, the belief that wisdom lies in the beliefs of the multitude. There are some topics on which expressions of opinion by many experts are illuminating. There are other topics on which expressions of opinion of the same experts are worthless, because they have given the matter inadequate study.



AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

EASTERN PENNSYLVANIA CHAPTER

JOHN D. CASSELL, Chairman

GEORGE W. BARR, Secretary, Land Title Building



THE regular monthly meeting of the Chapter was held at the Engineers' Club on Thursday evening, February 8. At the meeting it was decided to hold the annual banquet at Kugler's Restaurant at 6.30 P.M. on March 8. The annual election of officers will also be held at that time.

The Nominating Committee presented the following list of names as nominees for various offices to serve during the coming year:

For President:

Mr. E. T. Murphy.
Mr. G. W. Barr.

Vice-president:

Mr. J. T. J. Mellon.
Mr. A. C. Edgar.

Board of Governors:

(three to be elected)
Mr. J. D. Cassell.
Mr. E. S. Berry.

Secretary:

Mr. Geo. Boon.
Mr. H. A. Terrell.

Treasurer:

Mr. H. P. Gant.
Mr. A. S. Mappett.

Mr. W. G. R. Braemer.
Mr. W. W. Rice.
Mr. W. J. Robinson.

The subject presented at the February 8th meeting was "Modulating and Vapor Heating," by Mr. C. B. Haynes. Mr. Haynes very clearly indicated the advantages derived from this form of heating in certain types of plants, and dwelt especially on the absolute regulation and control of a vapor heating system.

He pointed out that if a large assembly room was to be lighted, it would not be good practice to simply install one very large light which would either be burning or

extinguished and could not be controlled to the extent of lessening the illumination by degrees. On the contrary it is customary to install a number of lights, so that one or more may be allowed to burn, the remaining lights being extinguished, thus giving any degree of illumination desired.

As an analogy, he explained that it was just as reasonable to so install a heating system that the degree of heat could be absolutely regulated, as it is to install suitable lighting system.

If one straight steam or hot water radiator is installed in a large room, it is only possible to have all or none of the heat on the radiator. With modulating or vapor system, however, it is possible to regulate the amount of heat given off by the radiator by means of the modulating valve which only permits a definite amount of steam or vapor to pass into the radiator, thus giving a definite and easy means of heat control.

When this system is properly installed, there are no air-valves on the radiators and no sputtering of steam or dripping of water on floors and carpets.

In addition to the flexibility of this system better economy in operation is also secured.

Mr. Haynes further went into the details of the installation of this form of system, and showed a number of diagrams to indicate the proper method of installing the radiators and piping systems.

After the talk this subject was discussed at length by several members, and all felt that Mr. Haynes' paper had been very instructive as well as most interesting.

THE PUBLICATION COMMITTEE APPRECIATES THE COÖPERATION OF THE MEMBERS OF THE AFFILIATED SOCIETIES. IT IS HOPED THAT ALL OF THE MEMBERS WILL TAKE A PERSONAL INTEREST IN FORWARDING TO THEIR ASSOCIATE EDITOR SUCH ITEMS AS THEY MAY HAVE AVAILABLE.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS .: PHILADELPHIA SECTION

H. P. LIVERSIDGE, Chairman

W. F. JAMES, Secretary, 1442 Widener Bldg.

The March Meetings: March 8th—Joint Meeting with Franklin Institute, 8.00 P. M., Hall of Franklin Institute, 15 South 7th St. Subject—"DIELECTRIC LOSSES IN INSULATING MATERIALS," by Mr. C. E. Skinner, Research Division Westinghouse Electric & Mfg. Co., E. Pittsburgh. March 12th—Regular Monthly Meeting, 8.00 P. M., Engineers' Club. Subject—"HIGH FREQUENCY HIGH VOLTAGE APPARATUS." The name of the speaker will be announced later and the paper will deal with work done by the Research Department of the General Electric Co. All members of the Engineers' Club and their friends are cordially invited to attend these meetings.

THE FEBRUARY MEETINGS

FEBRUARY, thanks to committees in charge, proved to be the most successful month in the history of the Philadelphia Section.

The first meeting was a Joint Meeting with the Franklin Institute on the evening of the eighth and the two hundred members present listened to a most interesting and instructive talk by Professor Alexander Gray, of Cornell, on the subject of "Modern Dynamo Electric Machinery with Special Reference to Power and Traction Uses." We are indebted to Professor Gray for a pleasant and profitable evening.

On the evening of the twelfth the Section paid its respects to the student members and the students of the various engineering schools in this vicinity. "Students' Night" was something new in a Philadelphia Section programme, but we can safely predict that it will again appear in the future years, as the students responded in force, the total attendance of two hundred and fifty showing conclusively the general interest in the subject of the evening—"The Engineering Graduate and His Opportunities."

The University of Pennsylvania, Drexel Institute, Princeton and Lafayette were represented in the student attendance and a delegation of twelve men arrived from Lehigh with Professor Esty. A number of the students entered into the discussion.

The first speaker, President W. H. Buck, of the American Institute of Electrical Engineers, spoke of the graduates' opportunities "In Institute Work," and then emphasized the necessity for the young engineer associating with and studying men of affairs so as to develop broadly and develop the ability to meet and deal with men in all walks of life.

Mr. Buck also mentioned the efforts being made to gather statistics as to the engineers available for service in event of international difficulties and pointed out the great demand for electrical engineers to become familiar with the work of the Signal Corps.



Mr. George P. Baldwin, District Manager of the General Electric Company, followed Mr. Buck and we are glad to be able to print elsewhere in this issue Mr. Baldwin's instructive remarks as to the graduates' opportunities "Along Commercial Lines."



Mr. W. C. L. Eglin, 2nd Vice-president of the Philadelphia Electric Company, the third speaker, presented the opportunities "In the Electrical Public Utility Field," and described some of his experiences with the engineering graduate, bringing out forcibly the reasons for the successes and the failures which had come to his attention. We

hope Mr. Eglin will find time in the near future to briefly outline his talk so that we can present it to the readers of the PROCEEDINGS in a complete form.

The discussion which followed the presentation of the papers brought out many interesting experiences and as previously stated several of the students entered into the discussion.

Preceding the meeting seventy-five attended the informal dinner at the Club and immediately following the discussion a substantial luncheon was served in the Club dining room.

In the future when a "Students' Night" is announced, be on hand for an enjoyable evening. Those who attended on the twelfth do not need this advice—they will be there.



The Commercial Field for the Engineer

An address delivered at The Engineers' Club, Philadelphia, Pa., on "College Students' Evening" of the A. I. E. E.

By **GEORGE P. BALDWIN**

DISTRICT MANAGER OF GENERAL ELECTRIC COMPANY

MR. CHAIRMAN and gentlemen, I wish to express my appreciation of the honor that you have conferred upon me in asking me to speak this evening.

I fear that engineers are sometimes inclined to regard the men on the commercial side of engineering the same as an air compressor,—"a lot of hot air on one side and a perfect vacuum on the other." I hope to show you this is an injustice.

Twelve billion dollars is invested in the electrical industry in the United States. The annual gross income is two and one-half billion dollars and the number of workers employed about one million.

In 1916 there were about fifty thousand miles of street railroads. Each year we add about five hundred miles of track and one thousand street cars.

Twenty-five hundred miles of steam railroad have been electrified in about the past twenty years. The electrified mileage is being daily increased on account of the advantages that have been proven. But there remain about three hundred and seventy-five thousand miles of steam roads *not yet electrified*.

The water power developments in the United States now have installed about six million horse power, but enough water is running to waste every year to equal the daily labor of nearly two billion men,—or thirty times our present adult population.

The central stations of the United States have about five million kilowatts of generating apparatus installed. In the past their principal source of revenue was from current sold for electric lighting. They now look to the sale of power for a greater revenue. The market to be invaded will involve:—The displacement of twenty million horse power of isolated plants, fifty million horse power of steam locomotives, together with more and more power for street railroads and current for household uses.

Five and a half million homes are electrically lighted; nine million household appliances—heating devices, washing machines and the like, are installed. But *fifteen* million houses are not lighted electrically; and far less than 1 per cent. of the homes in this enlightened land are wired for complete electrical service.

One electric horse power will do the work of ten men without tiring. In other words, a one horse power motor working continuously will do the work of thirty men in eight hours. You can buy current to run this motor for one year for about fifty dollars. To hire thirty men for one year will cost about twenty-five thousand dollars. And yet despite this marvellous economy of electric power, the women in our homes are wasting their strength

in domestic drudgery, when electricity is available for their emancipation.

In America's industries there is a large and increasing demand for more electrical equipment, more expert service, more elaborate improvements to obtain increased output and efficiency, and still more delicate refinements in the various processes. The demand is growing because it has been proven that electricity permits easier, more rapid, and cheaper production in old processes, and that it has also endowed the world with new products which would otherwise never have been discovered or would have been impossible to produce.

A detailed list of the thousand and one fields of commercial activities on the part of electrical engineers is impossible here. There is hardly a commodity known to civilized man, be it derived from the animal, vegetable or mineral kingdom, but what is worked upon by electricity in *some form* between the raw material and the finished product.

Consequently, there is an unfilled demand for skilful commercial engineers to introduce the products of the central station and the electrical manufacturer in these thousands of industries.

Every year there is spent on an average by every person in the United States, twenty-three dollars for electrical service and material. Of this amount four dollars goes to five thousand central stations and four dollars goes to the electrical manufacturers, dealers and jobbers. These millions were spent as a result of the development of but two generations. It is beyond our imagination to estimate what the next generation will spend.

The question of opportunity in the electrical engineering profession is quite beside the point, and what the young man of to-day has to consider, particularly the undergraduate in college, is how best to fit himself that these opportunities will be within his grasp.

The engineers and executives of America's greatest corporations of to-morrow are in college to-day. *They* will change the habits of a nation. The intelligent young man in college to-day can map his career *more* successfully if he appreciates what the future holds. What I would like to dwell upon specifically are the future *commercial* opportunities for the engineer.

A well-known engineer described how his conception of engineering developed as time went on. In the early stages of his college career his idea of engineering was limited to operation and maintenance, so he spent a vacation period in a central station. This experience developed in his mind the belief that construction was more interesting than operation. He next took a position with

a construction gang. This developed in his mind an interest in manufacturing. He finally entered the employ of a large manufacturer, in the Engineering Division. From designing details he was promoted to a position where he was assisting in the complete layout of large installations.

One afternoon on glancing up from his drafting board he noticed a party of visitors inspecting the works. It was a committee of business men being conducted through the plant by one of the commercial engineers, in order that they could observe the manufacturing facilities of the company. Then it dawned upon this young man that great installations must be sold before they are designed, just as they are designed before they are manufactured, erected and operated. Then *also* for the first time it occurred to him that the activities of the commercial engineer were essential and important.

Now, of course, this is only the conception of one man. He was quite well grounded in practical experience,—in the plant, on the road, in the shop and the drafting room,—before his mind turned to the commercial phase of the engineering profession. That man now holds a highly responsible position in one of our great corporations. He has found that what is commonly known as salesmanship requires just as intense, and involved study, as what is known as engineering; and that *successful* salesmanship requires a mental layout, and scheme of operation, that is as profound as engineering in its broadest sense.

Not long ago, many believed that salesmanship was an individual talent that would enable a man to sell anything,—candy or electrical machinery. Salesmen used to make the statement that they could sell *anything*, but to-day there are not many of these candy salesmen trying to sell electrical machinery. The universities of this country, with the assistance of the manufacturers, are devoting considerable thought towards training men for the commercial side of their profession.

The first requisite for a successful sales transaction is a scientifically designed and well manufactured product. The next element is an intimate knowledge on the part of the sales representative of this product and its application; and the third and most important feature, as far as the *commercial* engineer is concerned, is his ability to establish and maintain favorable relations with the people with whom he is brought in contact.

It is this ability to establish favorable relations and maintain them that produces results and for which the engineer who desires to enter the commercial field must train himself. He must have not only sound engineering knowledge, but must also supplement this with a well-rounded out knowledge of men, and affairs in general; this important feature, strange to say, is often lost sight of by the young man.

A man who is now a prominent executive in one of our engineering organizations nearly marred his career because of his neglect to realize this. The great turning point came when he was offered the position of Treasurer of his company. He hesitated. He considered it unfortu-

nate. He feared he would no longer remain an engineer. Yet he finally yielded to exterior pressure and accepted the position. Later developments proved, without question, that this was the best step he could have made, for it broadened his vision. And since he has crossed the threshold into the commercial world he has been able to make use of his engineering knowledge in a vast number of diverse fields. To-day he is *amazed* at the ignorance which caused him to hesitate.

His successful career is an example of what can be done in commercial engineering. The old school salesman has passed. The salesmen of to-day *must know his subject*. If he does not have a deep knowledge of engineering principles and their application as well, he *may* try to get business by means of guessed-at statements; or should he not yield to *this* temptation, he will find himself often in the position where he must confess his ignorance in the presence of the prospective customer and offer to send to the home office for an engineer. The doctrine of the survival of the fittest is rapidly eliminating this type. To-day the great manufacturers realize that the man to get the business should really be an engineer and be able to intelligently discuss the topics under consideration in all their phases. It has been proven that the old method was an economic waste,—the new method is modern business.

But the securing of this high type of commercial engineer involves a process of elimination: Experience has shown that out of one hundred engineers of high order, by no means all of them develop sound commercial judgment and are capable of *quick, accurate business decisions*. And of those who have this accomplishment, not all of them possess the requisite knowledge of human nature, the *tact*, the *ability to form acquaintanceships*, and those qualities which are summed up in the word "*personality*." If exact figures were produced, it would be surprising how few good engineers possess these first two requisites for a commercial career,—judgment and personality.

And still one more requisite must be fulfilled in order that a first-class engineer may make a successful commercial engineer, and that is English. He must make a clear, logical arrangement of his engineering facts; and, both in personal interviews and in writing he must submit these facts in *concise, impelling English*. A great author made the statement:

"If I *had* more time I would write you a shorter letter."

Thus did he emphasize the fact that concise expression is a difficult and rare accomplishment. So difficult is logical, simple, attention-riveting English, that of the above engineers who possess *judgment* and *personality*, surprisingly few will be found who possess this last qualification essential for successful commercial careers. And the fact should be further emphasized that the best place and practically the only opportunity for language training is during college days. After graduation your mind will be intent on *what* you say—not on *how* you say it.

(Continued on page 149)



SOCIETY OF AUTOMOBILE ENGINEERS

PENNSYLVANIA SECTION



JOHN W. WATSON, Chairman

A. K. BRUMBAUGH, Secretary, Autocar Co., Ardmore, Pa.

The next meeting of the Pennsylvania Section of the Society of Automobile Engineers will be held at the Engineers' Club on March 22d, the speaker and subject to be announced later.

THE February meeting of the Pennsylvania Section was a remarkably good one.

Mr. Steinmetz's talk on "The Automotive in War" was comprehensive and exceedingly well delivered.

He presented photographs of practically every type of application on the internal development of motors to

war service. His intimate knowledge of the subject and his warm interest in national preparedness made his address most effective.

An abstract of this paper will be published in the April issue of the PROCEEDINGS.

THE COMMERCIAL FIELD FOR THE ENGINEER

(Continued from page 148)

The greater your solid, practical, engineering knowledge, the greater will be your future in the commercial field, *provided* you possess a clear, definite knowledge of human nature and the world in general, and are able to express your thoughts in *concise, convincing English*.

To add a commercial training does not make one any less of an engineer. A bar of fine steel can be finished, tempered, ground to a fine edge, and yet it is still steel. Just so a commercial engineer is still an engineer. But he must be more than an engineer. To illustrate. You call on the President of a great railroad with the object of interesting him in electrification. You explain in detail from the point of view of railroading the savings that are effected. The President is interested. Then you start to talk about kilovolt amperes, power factors, diversity factors and the like. The President has been brought up in the profession of steam railroading and he is *not* familiar with electrical terms. His distress is shown when his eye wanders to the pile of unanswered correspondence on his desk. Unknown to *you*—you have lost his attention. Then he sagely remarks:

"Very interesting—I want you to explain these points to Mr. Thompson on the third floor," and he politely bows you out, shunting you off to a subordinate. It then occurs to you that you *have not* been given an invitation to call again. *Your mind* and that of the President's *have not met* because of *your* foreign tongue. An interpreter was needed. You had engineering knowledge and engineering skill, but you *did not possess the judgment to know* when you were in danger of losing the President's attention.

Moreover you *lacked* the tact to regain his attention or to obtain another interview.

Knowledge and language are the two master tools of business,—the language that you used was not adapted to the work. It is as though you were trying to cut diamonds with a saw. To be sure you were articulate—sounds emanated from your mouth, but they were not sensed by the commercial ear. *Truthful* and *accurate* as your statements may have been, they were not comprehended.

I would like to impress upon the young men in this audience that they fully avail themselves of the manifold advantages offered by the Universities of to-day; that they beware of the habits which have been the undoing of the old school commercial man now almost entirely displaced; that they remember, as Francis Bacon wrote,

"Reading maketh a full man
Writing an exact man, and
Conference a ready man."

and that upon graduation they will decide to build their careers upon the rock of sound engineering experience and practice. By so doing they will automatically find themselves associated with *real* men—men who are doing things in the world to-day. Such association and practice will undoubtedly develop a mind capable of meeting other minds on equal terms and swaying them.

Finally, every man who has succeeded and has come to the front has had one axiom—"he *tried* to do a little more than the other fellow and he *tried* to do it a little better."



TECHNOLOGY CLUB OF PHILADELPHIA



D. K. BULLENS, Chairman

C. J. WALTON, Secretary, 1421 Arch Street

IN place of its regular meeting the Technology Club held a concert and dance at the New Century Club on the evening of February 3rd. The combined musical clubs of the Institute gave the concert, the boys later being entertained over night by some of the local alumni. About 130 alumni and friends were present at the concert.

FLOOD LIGHTING

(Continued from page 142)

for any flood lighting installation. This, however, is generally unnecessary. With the projectors in place, it is a very easy matter to so train them and arrange the spread of the beams (by means of the focusing device on the projector) as to cover the area to be lighted to best advantage.

Flood lighting projectors are available giving almost any desired spread of beam, and for those who wish to work out flood lighting problems in greater detail, the manufacturers of such equipment can furnish distribution curves of their equipment. In lieu of such curves, the projectors can be easily tested and curves made locally.

The popularity of flood lighting has brought about the development of quite a number of different makes of projectors, and this number is being steadily increased. The installation on the Philadelphia City Hall tower is of interest. Three hundred and four flood lighting projectors are used for this, each containing a 500 watt flood lighting lamp. As part of this tower is covered with bronze, having a very low coefficient of reflection, it presented a very difficult lighting problem. Five times the intensity of light used on the gray granite part of the tower is thrown on the bronze. The disposition of the beams from the projectors, which are mounted in groups on the roof of the City Hall, is as follows:

Forty are trained on the stone part of the tower, 80 on the clock part, 144 on the dome and 40 on the statue and pedestal.

Among other notable installations are the Statue of Liberty in New York Harbor, the Soldiers' and Sailors' Monument in New York City, a Civic Celebration in New Haven and a pageant in Newark, N. J.

RUSSIA'S FIRST PLATINUM REFINERY

THOUGH Russia has long been the world's chief provider of platinum—a metal of very high industrial importance—it was not until March, 1916, that platinum ores began to be refined in Russia. This notable advance in Russian metallurgy has been carried on at a factory built and operated in Ekaterinburg by a company of Nikolo-Pavdinsk mining district.

Several considerable advantages to Russia are in-

Coming Meetings:

March 7th.—“Radio Work,” by E. D. Forbes, of the Philadelphia Navy Yard.

April 4th.—Election of Officers.

“Telephone Engineering,” by P. E. Tillson, of the Bell Telephone Company.

involved. The Russian platinum industry is made for the first time independent of foreign markets. Russian refining of platinum also secures the use and value of other very important associated metals, especially iridium, hitherto left in the hands of the foreign refiner.

Moreover, though the absolute value of the associated metals is not very great, the increasingly great use of these metals and of platinum for technical purposes seems to offer Russia, now that she is refining her own ores of these metals, the opportunity to build up a manufacture of platinum ware that will ultimately reach large financial proportions. Though any great increase in the output of Ural platinum would tend to lessen its price on the world markets, the demand for the metal, already very great, would probably much increase as soon as a lower cost made it available for a wider range of uses. It seems certain, therefore, that the institution of Russian platinum refining is a landmark in Russia's metallurgical and manufacturing progress.

—Russia.

CORROSION OF CAST IRON

CAST iron imbedded in moist soil is subject to a peculiar form of corrosion known as “graphitization,” “iron cancers,” etc., in which it is converted locally into a soft, friable, gray mass, according to B. Bauer and E. Wetzel, two German authorities, as quoted by the *Journal* of the Society of Chemical Industry. The authors have investigated a number of cases of corrosion of this type and also made experiments with the object of producing similar effects in laboratory tests. Their results indicate that the fundamental condition for the production of corrosion of this kind is the presence of water in the liquid state. The phenomenon is usually associated with gray cast iron, but white cast iron may be corroded in a similar manner. The corrosion is accelerated by the application of an electric current—for example, by stray currents in the soil—but also takes place, though much more slowly, in the absence of external electric currents. The oxidation products of the iron, in a spongy condition at first, are retained in place by the network of graphite in gray cast iron, or of cementite in white iron, and are gradually agglomerated to a more or less firm mass. In gray cast iron the corrosion appears always to proceed from the laminae or graphite and gradually to spread outward.

—The Iron Age.

Mobilizing Our Industrial Resources

In the February issue of "Valve World," a live journal published by the Crane Co., Chicago, appear extracts from a paper on "Mobilization of National and Industrial Resources," by A. L. Humphrey, Vice-president and General Manager of the Westinghouse Air Brake Company. This paper was presented before the Engineers' Society of Western Pennsylvania, at Pittsburgh, and was printed in a booklet, which contains matter of vital importance not only to American industries but to our national welfare, recently issued by the Westinghouse Air Brake Company, at Wilmerding, Pa. After paying a deserved tribute to the engineering profession, Mr. Humphrey said:

COMFORT IN PREPAREDNESS

I BELIEVE that the patriotic citizens of this country would feel more at ease and would maintain a more calm repose, like the farmer snugly nestled in the cyclone cellar at the time of nature's upheaval, if they knew that we had at least a semblance of an Army and Navy that would keep off the ravages of foreign invasion. * * *

Many argue that we are sufficiently prepared. The practical refutation of this argument would cost dearly in lives and wealth. According to naval and military experts, our present supply of ammunition would last but four weeks of real modern warfare, and might be consumed in a matter of days. * * *

MORE THAN "SPIRIT" NEEDED

The "Spirit of 1776" would undoubtedly be fanned into flame once more were a common peril to arise, but modern warfare needs that and vastly more, too. Conceive, if you can, of the scale of modern military operations.

At the outbreak of the war in August, 1914, the German army had six cannons for each 1000 infantry and cavalry and 6000 shells for each gun, making 36,000 rounds for each 1000 men. Taking four million troops in the first and second line ready to call, a total ammunition supply for artillery of 144,000,000 shells was on hand before war was declared, and *even this was not enough*.

An American Army officer estimates that twice this initial supply has been manufactured and consumed since, making a total consumption of almost half a billion shells.

During seven hours' time 80,000 projectiles were dropped into a space of 1100 yards front by 50 yards deep in the Western front in Europe. The tremendous task this rate of firing imposes upon ordnance makes the modern gun partake of the nature of ammunition in its rapid depreciation and need for continuous replacement rather than its former nature of a permanent possession.

In a word, an army numbering millions requires in its operations vast quantities of supplies of all kinds. Unless these supplies are forthcoming as needed the nation's defenders, however intelligently organized and

splendidly trained, will be quite helpless. Such has been true of some of the nations engaged in the present war, most notably Russia.

SOME UNPREPAREDNESS FACTS

While, as already pointed out, we are unprepared almost to the point of sinfulness in the matter of ammunition, the conditions with respect to rifles are even worse.

From information I have been able to obtain, the present capacity of the United States arsenals for manufacturing modern rifles is between 800 and 900 per day with the possibility of going as high as 1300 and 1400 per day.

It requires no mathematical knowledge to compute that these plants, turning out rifles at the rate of 1400 per day, could only manufacture 500,000 in the course of a year's time, and that on this same basis it would take four years to provide rifles for an army of two million men—a very small army, by the way, if we should find ourselves in any serious "scrap" with a first-class power.

A DANGEROUS CONCENTRATION

Until very recently the entire production of munitions of war, outside of Government arsenals, was concentrated in the vicinity of New York City. All of the materials, other than steel, entering into the manufacture of ammunition came from New England, principally Connecticut and Rhode Island.

Our entire requirements in the way of torpedoes, so far as I have been able to learn, are filled from the same general neighborhood. Moreover, within less than 100 miles of the Atlantic seaboard are located our only gun-making plants, our ship-building concerns, our powder mills, our woolen and worsted mills.

Last, but not least, while many states in the Union contribute to the nation's supply of copper, fully 90 per cent. of it has to be shipped to New York or Baltimore, there to undergo the electrolytic process of refining.

It makes one shudder to think that an enemy, after having effected a landing on the Atlantic Coast, might within a few days subjugate the entire territory mentioned and thus leave the rest of our vast and rich country absolutely helpless.

The conditions with respect to some of these things have, of course, improved wonderfully during the past year. A number of large plants in Pennsylvania and Ohio have been equipped for, and are now turning out, ammunition in great quantities. The eastern part of Pennsylvania is also now contributing largely in the way of modern rifles. Much more remains to be done, however, to make the country at large independent of the highly specialized factories on the Atlantic seaboard, and there is no time like the present to spread the gospel of industrial preparedness among the manufacturing plants of the West and the Middle South.

IMPORTANT GOVERNMENT DUTY

One of the most important duties that the Government and its Advisory Boards should perform is that of selecting manufacturing sites in the interior where may be had immunity from attack in time of war. The plants for working up raw materials could probably be so distributed as to avoid the possibility of cessation of manufacture incident to an invasion.

Large Government plants for manufacture of powder, as well as the other munitions of war, should be located in the interior and Middle West and arranged to provide for organization units capable of expanding or contracting at any time as requirements might demand.

A reasonable number of expert workmen should be constantly employed in a small section of extensive plants and they would form the nucleus of the entire emergency organization in case hasty expansion should become necessary. This, in my opinion, would be the ideal arrangement.

The Government should buy everything itself and, with machinery already in existence, it could equip for a very nominal sum extensive plants that would be capable of turning out enormous quantities of ammunition in a very short time, besides furnishing trained experts for independent plants. Large stores of raw materials of all kinds that go to make up complete appliances and that could be carried indefinitely without fear of deterioration from age could be maintained at these places.

MOBILIZING MATERIAL RESOURCES

In mobilizing our material resources it is necessary, first, to ascertain our probable needs in the event of war. We should then investigate and make record of the resources from which these needs may be supplied, and finally execute all preliminary measures necessary to stimulate production. The problem is a vast one, and fully equal in importance to the training of military personnel.

The supplies necessary are not limited to weapons, ammunition, foodstuffs and clothing, but include the great bulk of the products of the farms, mines, forests and factories.

Our material resources exceed those of any other nation and are ample for the prosecution of a great and protracted conflict. It seems to be the accepted theory of

all those best versed in the subject, however, that we are very poorly organized from the point of view of military necessity.

Through my active association with a combination of interests during the past two years, in an undertaking to furnish ammunition for European nations, I am perhaps in a position to appreciate more fully than those not so situated the seriousness of the lack of system that has so largely contributed to delays and extravagances in the preparation and manufacture of munitions for the belligerent countries.

Fortunately for us as a nation, Europe, and not the United States, has paid for this inefficiency and for these shortcomings. Let us hope that the experience acquired in this direction by our manufacturers and engineers will be of undoubted benefit to our own defensive policy.

RESERVE OF WAR MATERIAL

In the event of war the regular and volunteer forces of our country will be called at once to the colors and sent to the front as rapidly as they can be equipped. To expedite this equipment it will be necessary to have on hand a reserve of material, which calls for preparation in times of peace.

This reserve should obviously be no larger than necessary; it will be great enough in any case. Its storage and care will be expensive. Some of it will become obsolete from time to time, some of it will deteriorate and become useless in storage. All of it will represent an investment paying no direct return except in case of war.

The amount of each item of this reserve will depend, first, on the requirements of war, and second, on the predetermined rate of production and delivery subsequent to the outbreak of war. It is the province of the general staff to contemplate certain contingencies and the enrollment, training and equipment of successive levies of men to meet these contingencies.

CARD INDEX OF AMERICAN INDUSTRY

Under the direction of the Advisory Board Committee on Industrial Preparedness, thirty thousand American engineers are making a card index survey of American industry so that it may be prepared for its vital part in defending the country if need comes. This plan of indexing involves:

First: Getting an accurate census of all manufacturing plants as to their present equipment and capacity, and their flexibility and needs for rapid expansion of output.

Second: Having each plant equipped with the necessary tools and become familiar with its assigned work by making a small amount of munitions each year.

Third: Enlisting skilled labor in the service of our Government to make munitions in time of war instead of permitting it to go to the battle front.

ASSIGNED ANNUAL PRODUCTION

When this survey has been completed and when each manufacturer has been assigned a certain task that he

must become proficient in performing, I believe we can confidently face any danger that may threaten the nation.

There is no question that Germany's excellence in the organization of industries, by requiring each manufacturing plant of consequence to install the requisite machinery and train its employees in the making of shells, if only a small quantity each year, under the strictest supervision and subject to the most rigid specifications of the army, has been one of the principal factors that have brought many of the achievements of her forces in the field.

In this connection, one of the greatest national services that could be rendered by the manufacturers now engaged in the production of ammunition for foreign countries and who, at great expense, have mastered the intricacies of the art, would be to impart the information so gained to managers of other plants that are likely to be enrolled in a general preparedness scheme. * * *

In return for his work the manufacturer should receive the costs involved in producing his assigned output. By this is meant the entire cost, which includes a fair return on the investment. I submit that to accept less than this would be suicidal; it would lead the industries of the country into bankruptcy and result in economic chaos.

FOREIGN CONTRACTS AND PREPAREDNESS

Our country has made an excellent start along the line of industrial preparedness in that a large number of the most important industrial concerns of the country have during the past eighteen months contracted with European governments for the manufacture of the special lines of ammunition used in the present war. Special machines by the hundreds have been installed and thousands of men have been so trained that they have become expert in turning out shrapnel, rifles, field guns and high explosive shells of all sizes. These men and machines will form a most valuable nucleus for the preparedness propaganda and afford a most splendid opportunity for this country to avail itself of conditions now existing. * * *

COST OF GETTING READY

The company with which I am directly associated was compelled to spend between six and seven million dollars in constructing buildings, providing machinery, manufacturing jigs, gauges, patterns and special appliances and for the purchase of materials before one single payment had been made by the foreign governments. Assuming that the other companies forming our combination made corresponding expenditures, the total amount paid out in getting ready for the work was from twenty-five to twenty-eight million dollars before one cent of profit was received. * * *

We sincerely believe that this great country of ours should fortify itself against invasion. In case this nation ever becomes imperiled our patriotic manufacturers will respond nobly, prompted solely by the desire to serve the American people, who have made the great industries of

this country possible, and whose coöperation is so essential for a successful preparedness undertaking. The much-maligned, so-called "Industrial Barons" stand ready to contribute not only their wealth and resources, but their time as well, for the actual good of the cause. * * *

SOLDIERS BACKED BY WORKERS

It has been estimated that for every man needed at the front to operate the machines of actual warfare there are needed three men at home to furnish him with the supplies for his operations. Thus for an army of two million men at the front six million men are needed in the workshops to keep supplied the men in active service.

When one considers that there are not more than 3000 truly expert gauge makers in the country, the point where they can render most effective service is fully apparent.

The work of the Committee on Industrial Preparedness then is most wise in listing our skilled artisans that they may not be foolishly sent to the front in the time of need and thereby impose starvation upon military operations.

The enlistment of skilled labor is of vital importance and all measures, also, which may be developed to imbue these men with a sense of their patriotic trust and honorable service to their country.

Surely it is just as essential that the workers of the country be mobilized as it is to mobilize the industries and material resources themselves, and let us hope that once skilled labor realizes that upon it rests grave responsibilities in case of national danger and that their constant and faithful attention to duty at the work bench may prove the salvation of our country, our men will rise nobly to the occasion and do honor to this great country even as do those who are actually shedding their blood on the field of battle. * * *

CLASSIFICATION OF MATERIALS

Materials required for the conduct of war may be classified under two general heads:

First: Commercial materials, tools and appliances; that is to say, those which are manufactured and used in large quantities in times of peace.

Second: Materials or equipment which are peculiar to warfare and are not ordinarily manufactured at all, or to a limited extent only for commercial purposes, and which cannot, therefore, be readily obtained on short notice.

The line of demarcation between the two classes cannot be definitely fixed. Examples of the first class are axes, barbed wire, automobiles, shoes, anæsthetics and dynamite. To the second class belong military rifles, portable entrenching tools, haversacks and pontoon boats.

The gathering together of material for the manufacture of war munitions means that a demand is made upon the resources of the country for an enormous amount of commercial material, much larger than is required in normal times.

It also means a demand for special materials. By

special materials, I mean those which are manufactured in small amounts in normal times, but would be required during times of war in much larger quantities.

In estimating the amount of a given material that can be obtained or manufactured in a certain period of time, it is necessary to not only judge as to the rate of manufacture, *i.e.*, the amount that can be manufactured in a given period, but also where the raw materials used in the manufacture of the given article may be obtained.

A great many materials are built-up materials; that is, the finished product is made or manufactured from several other manufactured products, which in turn are combinations of still other products. * * *

ONE GOVERNMENT TASK

One of the most crying needs in the recent mobilization of American industrial talent in the service of foreign governments has been for gauges, jigs, machine fixtures and other special tools. In building up an organization no feature is of greater importance than the tool room and gauge department, as a very large number of special tools and attachments to standard machines are required to obtain accurate work as well as output, and since these are necessarily of a special nature and in many cases must be worked out by experiment, the character of the tool room will determine to a large extent the results to be obtained in production. * * *

Profiting by the experience obtained by the manufacturers in their present undertakings along the ammunition line, the Government should manufacture a supply of jigs, fixtures, gauges, cutters and special tools far beyond any possible expectation of requirements; doing this after the designs have been agreed upon jointly by the Consulting Board, the manufacturers, and the Government officials. * * *

UNIVERSAL TRAINING NEEDED

Having sketched briefly the problem of industrial mobilization I wish to venture a word on the problem of personnel at the battle front—the consumer of the industrial output.

I am not a believer in militarism—God forbid it—but I do think that some form of universal training would not only make our country secure from aggression, but would result in increasing the physical, mental and moral fitness of the rising generation, besides inculcating in them the right kind of patriotism and proper regard for law and order, the natural result of which would be to do away with mob rule and riots now of such frequent occurrence.

We look upon militarism with abhorrence, as being inimical to free institutions. Moreover, the maintenance of a huge army would not be tolerated by a democracy, because we all know that in every problem of administration the most important element is the human element, and this knowledge must prompt us to stick to the democratic idea; for no manager of a political, commercial, industrial or transportation organization ever attained high ideals

throughout his organization unless he thoroughly reckoned with the all-important human element.

The commercial and industrial establishments of our country long ago recognized this truth, and the most successful business of to-day is the one conducted according to the rule of "square deal" and where a spirit of democracy pervades the administration.

THE ALL-IMPORTANT HUMAN ELEMENT

If this is true in the business world, it is applicable also to governmental institutions, and I know of no place where it would be of greater service to the nation than in the Army and Navy.

Officers in these branches ought never to forget that they have been educated and trained as public guardians and that their superior knowledge and official position do not create within them the right of autocracy nor a license to treat with disrespect or contempt the private whose enlistment was actuated by patriotic motives.

Managers of big institutions know that discipline and respect can be maintained without resorting to the tactics of a despot, and I predict that a large and loyal volunteer army will never be forthcoming in this country unless the officers of the Army and Navy also take the cognizance of this fact and look upon the private not as a mere mechanical unit, but as a free-born American citizen to whom the nation owes a debt of gratitude.

TRAINING IN THE SCHOOLS

I believe that every man should have the advantage of some military training during his high school, preparatory school and college life, that is, before he has settled down to make his own living and established a home. If this training is deferred it will be a financial hardship on a great many to temporarily abandon their regular employment for a course of training each year.

In a large majority of cases there is a period between the termination of the school or college term and the assumption of family responsibilities where a young man could, without serious inconvenience, leave his employment for a given time each year to go to the training camp and rehearse what was taught him during his school days.

Every boy has a right to be well born, and also has as much right to a military training as he has to a public school advantage or the right to spiritual worship.

Military training will teach him how to defend his country in case of need and will also conduce to better health and stronger mentality, besides instilling in the boy that respect for discipline and system which makes for the best kind of citizenship.

TECHNICAL TRAINING

In addition to universal military training of boys and industrial training of men it would seem that proper provision should be made for a considerable increase in the technical military training facilities of our country.

All are agreed that while our shortage of men is serious, our lack of well-trained officers is even more

serious. Where universal military training in a democracy seems to find small favor any scheme that will most conduce to the rapid training of volunteers in case of need is a preparedness measure of extreme importance.

The development of a large body of carefully trained officers is a scheme more effective than any other for this purpose, I believe. I greatly favor the suggestion made some time ago that the Federal Government establish in various parts of the country schools where young Americans could receive free the kind of technical education now given at West Point.

However, since we do not want to become a so-called "Military Power," the course in the proposed schools should be so modified that this technical training would turn out graduates equally capable for civil pursuits. On graduation these young officers would be assigned to commands, to practical military encampments or as instructors in public schools or colleges and there given the opportunity to apply their theoretical training.

SUBJECT TO WAR CALL

After that all but a chosen few could be turned back into civil life, subject to recall to training camps for brief periods each year or two, all the while keeping themselves thoroughly informed and up to date by following the developments in military science.

History shows that the most successful American army officers were those that had experience of the kind just described. In case of war these thoroughly trained officers would be subject to immediate call, ready to assume charge.

Each year these schools would, like other universities of learning, turn out thousands of men highly trained and fully equipped for profitable civil pursuits. Just that many thousands of young men unable to pay for college courses would be provided with proper education and the influence on national development would most assuredly be of the highest order.

INDUSTRIAL APPRENTICE SCHOOLS

Most of our great industrial establishments and a good many of our big railroad systems maintain schools for apprentices. These apprentices are usually poor boys who cannot afford to go to school after they have finished the eighth grade in our grammar schools, and whose education is supplemented by a thorough course of training under competent instructors furnished gratuitously by the manufacturers and railroad companies—a course of training that in three or four years puts them in line for almost any position in the organization.

The fact that these boys are willing to work for a mere pittance during three or four years in order to supplement their common school education shows that they are made of the right kind of American stuff and would furnish ideal material for the military schools I have just described. * * *

SOME PERTINENT DEDUCTIONS

Effective mobilization of our industrial resources must be based upon organization and intelligent leadership.

These factors in industrial progress are gradually being recognized and put well to the front, as is evidenced by the movement for the conservation of our vast resources and by the more rational and liberal attitude toward big business on the part of the thinking public and their representatives in legislative assemblies which heretofore have retarded rather than fostered industrial progress.

The war in Europe had been under way for more than a year before some of the belligerent countries were able to equip the men who voluntarily offered their services. The governments put forth their very best efforts, yet the mobilization of their industries lagged, due to lack of foresight. This lesson is certainly an impressive one and we should not fail to take it to heart.

MONEY AND PREPAREDNESS

I remember reading shortly after the close of the Spanish War a statement made by Lyman J. Gage, then Secretary of the Treasury, that there were three things in warfare that were absolutely essential, namely, money, MONEY and MONEY.

A greater truth had never been uttered, and I believe that the statement will apply to modern conditions with equal force.

The present European conflict has taught us, however, that in addition to the requirements enumerated by Secretary Gage, there must be the all-important item of preparedness. Had England been one-tenth as well prepared on land as she was on sea this war, according to the best military experts, would have been of much shorter duration.

Like ourselves, England trusted to her resources, and when the fatal blow came she had to pay dearly in life and property for what could have been well provided for in times of peace. Her experiences taught her and, if we are wise enough to heed them, will teach us that modern warfare demands the closest coöperation of all economic elements in a nation, and, moreover, that the people must be brought to realize, by means of a just, efficient and successful Government, that they have a country and national institutions worth fighting for and making sacrifices for, such as have been made so readily by Germany, to whom all of us are wont to look for lessons when the game of war is under discussion.

The United States in its present condition can hardly be regarded as a cohesive nation. We are much too inclined to be selfish, and unless we learn to subordinate our individual selfishness to a general recognition of broad public rights and needs, we cannot hope for the most effective coöperation in case we have the bitter misfortune of becoming involved in war.

OUR NATIONAL IMMATURITY

As a nation we are yet young and childish, and immature in many of our judgments. We are self-confident and physically exuberant and strong. We look back upon our brief history with eyes and minds that tend to enlarge upon our national accomplishments.

We have not looked forward enough to realize that war is no longer a question of men or resources, or even money; but of a vast complex system of organization, shops and mills, and every industry, of all skilled labor, of all executive intelligence, of all financial foresight and acumen; in short, of ability to make use, and effective use, of these resources and in the minimum of time.

But a great process of education is now in progress. Europe is teaching us graphically—by moving pictures, as it were—what war in all its phases means to-day, and how ill-prepared we are to meet any such terrible stress.

Of what use, indeed, are millions of men if they are untrained and uninstructed; of what use are guns on land or sea if we have not enough qualified machine shop capacity in the whole United States, as at the present time, to supply ammunition; of what use are foodstuffs and clothing, and supplies of all kinds if they cannot be purchased and delivered quickly to the armies and navies which need them; of what use is vast national wealth if it cannot be used systematically and in order for things needful; of what use are great transportation systems without adequate rolling stock or terminal facilities, or centralized executive direction?

We are like the sailor in a small boat in mid-ocean surrounded by miles of water and not a drop to drink. We are like the traveller in the desert who sees all the glory of the mirage and does not realize that it is only a picture of what might be.

ENGINEERS AS LEADERS

The engineers of the country may well lead in the new idea of national pride and greatness; that every man is a citizen for *service* to his country, be that service hard or easy as it may. Let us teach thrift as the French have learned it, and economy in natural resources. Let us strive for efficiency as Germany has attained it in the useful arts and sciences. Let us teach the dignity of Labor, the rights of Capital (accumulated savings), and the folly of internal contentions and struggles which only waste and weaken. Let us teach intelligence and sound judgment to all the people, and quickly will the nation realize that great resources do not necessarily mean strength, but only when the whole process of bringing these resources to utility quickly has been evolved.

The manufacture of tungsten in the Liverpool district, England, has become important in the last two years. The ore is mined in limited quantities in Cornwall and Cumberland, but it was exported previous to the war. The first steps to make tungsten in England were undertaken by a Liverpool firm which established large works at Garston, Liverpool, and deliveries were begun in the first half of 1915. A second undertaking is that of the co-operation of 31 of the largest steel makers of England, who erected a plant at Widnes, in the same district. Ferro-tungsten is now sold at the maximum government price of 5s. 6d. (\$1.34) per lb. The American price is about twice this. —*The Iron Age*.

SOCIETY OF TERMINAL ENGINEERS

The Society of Terminal Engineers has just been chartered under the laws of the State of New York with headquarters in New York City for the purpose, among other things, of promoting the study of terminal engineering and mechanical freight handling as a specialty.

The new organization has three grades of membership, viz., members, associate members and juniors. The members grade is open to professors of civil and mechanical engineering, and engineers specializing in terminal work. Associate membership applies to officers and others connected with concerns manufacturing freight handling appliances and terminal equipment, and those whose work and interests enable them to co-operate in the aims of the society. Junior members comprise recent graduates of recognized technical schools who will specialize in terminal engineering and young engineers qualified to fill subordinate positions in terminal work.

A low rate of six dollars a year, without initiation fee the first year, has been fixed as dues for membership in the new Society which proposes to hold regular monthly meetings in New York in furtherance of its aims and objects.

The partial organization so far effected is:

President—H. McL. Harding, New York.

Vice-Presidents—Gen. W. H. Bixby, U. S. A., Washington, D. C., and John Meigs, Philadelphia, Pa.

Treasurer—W. J. Barney, New York.

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A SENSIBLE POSITION

THE example of many manufacturers in handling metric orders has solved the shop problem of making many of such products directly in the metric system. Any manufacturer who through ignorance, fear of confusion, or lack of enterprise is unwilling to attempt to meet the requirements of foreign trade should confine his attention to our domestic trade. He should not, however, be permitted to retard the development of foreign trade by his inertia or indifference to the metric system, which is now the legal system in 34 of the countries whose trade we seek. Still less should his opposition or his opinion have consideration in comparison with the judgment of those who seek earnestly and by all possible means the extension of trade with metric countries. The subject is too important to be decided by any except those who are either using the metric system or willing to do so to the full extent that the export trade demands. Recent experience has shown that many of the manufacturers can successfully make the change without undue difficulty.—*Dr. S. W. Stratton, Director Bureau of Standards, Washington; The Valve World*.

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CONTENTS OF THIS ISSUE

	PAGE		PAGE
Committee on Meetings	Inside Front Cover	The Zoning System	173
Announcement by J. C. WAGNER, Chairman		By EDWARD M. BASSETT, Esq., GEORGE B. FORD, GEORGE E. DATESMAN, ANDREW WRIGHT CRAWFORD	
Officers, Directors, Standing and Special Committees of Engineers' Club	158	Amendments to Rules and Regulations of the Bureau of Health of the City of Philadelphia . . .	183
Editorial	159	Road Building	185
Committee on Papers	160	By DR. J. H. SQUIRES	
Announcement by LEWIS H. KENNEY, Chairman		Society of Automobile Engineers	190
Secretary's Notices	161	The Automotive of War	
Business Meeting of the Club, March 20, 1917		By JOSEPH A. STEINMETZ	
Regular Meeting Board of Directors, March 13, 1917		Technology Club of Philadelphia	194
Positions Vacant and Positions Wanted	164	American Society of Mechanical Engineers	195
Committee on Membership	165	The Design, Construction and Equipment of a Modern Military Aëroplane.	
Candidates for Membership		By J. C. HUNSAKER	
"Vim, Vigor and Victory"	166	Average Results of Tests of Portland Cement	196
By S. M. SWAAB		Made during 1916—Department of Public Works, Bureau of Surveys Testing Laboratory.	
Committee on Public Relations	169	Illuminating Engineering Society	197
GEORGE R. HENDERSON, Chairman		Indirect Lighting System (Abstract)	
The Engineers' Club: Its Service to the Country in Time of Need.		By G. HARRY SWANFELD	
The Engineers' Club and the United States Naval Reserve Force	172	American Society of Heating and Ventilating Engineers	199
		Eastern Pennsylvania Chapter.	

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Contributions of all kinds on all topics of interest to the members of the Engineers' Club are cordially invited. All matter for publication, including advertising copy, must be in the hands of the Editor by the 15th of the month for the issue of the following month.

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Editorial

TO the casual observer of the rapid growth and building of our large American cities it must be evident that haphazard construction is not only universal, but it is also inviting economic waste and destruction. That the city of 1950 shall be immeasurably a better place in which to live than the city of 1920, there must be greater public regulation and restriction of the use of realty.

The Zoning System—more properly designated the Districting System—applied to city planning, as defined by the BOARD OF ESTIMATE AND APPORTIONMENT OF NEW YORK CITY, embraces “a comprehensive plan for the control of building development of private property,” and restricts the use of such property by regulating the use of buildings erected, by regulating the height of such buildings, and further by regulating the size of buildings with respect to the area of lot occupied. (See PROCEEDINGS OF THE ENGINEERS' CLUB, January, 1917, page 10.)

In European cities zoning has been practiced for many years. With reference to heights of buildings and the segregation of residential from industrial and business districts, the principle has been applied in recent years, in several American commonwealths. Its first adoption, however, in the comprehensive plan of a metropolitan city was the enactment, on July 25, 1916, of a districting law affecting the entire metropolitan area of New York City. Philadelphia has kept close pace in the passage of a councilmanic resolution authorizing the appointment by His Honor, the Mayor, of a Zoning Commission, which Commission is now actively at work upon the draft of a law to effect the carrying out of the districting principles of this city.

The power of restriction is derived from the exercise of police power of government, which makes for the public health, safety, convenience, comfort, and general welfare. It is one of the most difficult to define and limit and must be reasonably applied.

The question as to how far a property owner, in the assertion of his fundamental individual rights as a free citizen, may use his property as he pleases to the disadvantage of his neighbors' property, or to the public detriment, is one ripe for determination. Citizenship in a democracy at first resents restrictions upon individual rights. These are generally interpreted to mean the doing of what one pleases with his own, irrespective of how such action may affect the rights of others to do as they choose with their own.

If our great cities of thirty years hence are to be upbuilt in an orderly manner, evolving better and fitter citizens, public regulation must be recognized to subordinate indiscriminate private use to the public welfare. The Supreme Court of the United States, in a leading case in California, says: “There must be progress, and if, in its march, private interests are in the way, they must yield to the good of the community.”

The excellent papers of Mr. Bassett and Mr. Ford and the able discussion by Messrs. Datesman and Crawford, appearing in full in this issue of the PROCEEDINGS, are timely and give engineers in this community clear presentation of a subject that should be of paramount interest, as it is of importance.

THE COMMITTEE ON PUBLICATION DESIRES TO EXPRESS ITS APPRECIATION
FOR THE ASSISTANCE MR. JOSEPH C. WAGNER HAS RENDERED IN PREPARING
THE EDITORIAL AND EDITING THE PAPERS ON THE “ZONING SYSTEM”
APPEARING IN THIS ISSUE OF THE PROCEEDINGS.

Engineers' Club of Philadelphia

COMMITTEE ON PAPERS

LEWIS H. KENNEY, Chairman

ANNOUNCEMENT

MEETING OF APRIL 17, 1917, at CLUB HOUSE

THE paper of the evening, "**Submarines**," will be presented by **Mr. W. A. Hall**, Member.



The paper, to be illustrated by lantern slides and motion pictures, will give an outline of the development of the submarine from the time of Alexander the Great to the present. The slides include the collection of the late John P. Holland.

PRELIMINARY ANNOUNCEMENT

MAY 4, 1917.—*Special Club Meeting, at Witherspoon Hall.* The address of the evening, "**The Panama Canal**," will be presented by **Major-General George W. Goethals, U.S.A. (Retired)**, Honorary Member.

May 15, 1917.—*Annual Meeting at the Club House.* The President, **Mr. Emmett B. Carter**, will present an address on "**The Engineers' Club of To-day and To-morrow**."

MEETINGS FOR JUNIOR MEMBERS

APRIL 23, 1917.—*Meeting at the Engineers' Club.* Subject: "**Efficiency Engineering**."

1. **The Lay-out of Machine Tools in a Light Manufacturing Plant.** D. J. Matlack.
2. **Efficiency as Applied to Clerical Forces.** J. G. Allen.

Junior members are privileged to invite friends to the meetings.

PRIZE FOR JUNIOR MEMBERS

The winner of the prize for Juniors will be announced in a later issue of the PROCEEDINGS. The rules governing the award of prize were published in the November issue of the PROCEEDINGS.

Engineers' Club of Philadelphia

SECRETARY'S NOTICES

A BUSINESS MEETING of the Club will be held Tuesday evening, April 17, 1917, at 8.15 o'clock, at the *Club House*. In accordance with the By-Laws, Article V, Section 5, additional nominations for officers may be presented, in writing, at this meeting. The paper of the evening, "SUBMARINES," will be presented by MR. W. A. HALL (member). The paper will be illustrated with lantern slides and motion pictures.

A SPECIAL MEETING of the Club will be held Friday evening, May 4, 1917, at 8.15 o'clock, at *Witherspoon Hall*. The address of the evening, "THE PANAMA CANAL," will be presented by MAJOR-GENERAL GEORGE W. GOETHALS, U.S.A. (Retired), Honorary Member of the Club. The address will be illustrated with lantern slides and motion pictures.

ROBERT H. FERNALD, *Secretary*.

ABSTRACT OF MINUTES OF THE BUSINESS MEETING OF THE CLUB

HELD MARCH 20, 1917

The meeting was called to order by President Carter at 8.15 P.M. About 300 members and guests were in attendance.

The minutes of the Special Meeting of January 26, 1917, and the Business Meeting of February 20, 1917, as printed in the March PROCEEDINGS, were approved.

ANNOUNCEMENTS

The Board of Directors elected, at its last meeting, the following to membership: Active, 14; Junior, 2.

Mr. Edward H. Cahill, member of the Philadelphia Chapter, A. S. M. E., was elected to Active Membership, February 16, 1917.

Report of the Tellers of the Vote for the Amendments to the By-laws, Articles I to XII, inclusive:

"Mr. President and Members of
The Engineers' Club of Philadelphia.

"GENTLEMEN:

"Your Tellers have counted the ballots cast for and against the amendments to the By-laws, Articles I to XII, inclusive, and declare that 237 legal ballots were cast, as follows:

"For the amendments, 233.

"Against the amendments, 4.

(Signed) "GEORGE E. CROFOOT,
JOHN P. MUDD,
HAROLD GOODWIN, JR."

In view of the report of the Tellers, the President declared the amendments to the By-laws adopted.

The Committee on Nominations submitted the following report:

"To the Board of Directors,
Engineers' Club of Philadelphia.

"DEAR SIRS:

"On behalf of the Committee on Nominations, consisting of Mr. H. P. Gant, Mr. Henry Hess, Mr. T. C.

McBride, Mr. H. C. Snook, Mr. Paul Spencer, Mr. G. S. Webster, and the undersigned, I beg to report the following nominees recommended by this committee:

"For President, Mr. J. A. Vogleson.

"For Vice-president, Mr. W. C. L. Eglin.

"For Secretary, ———.

"For Treasurer, Mr. Jonathan Jones.

"For Directors-at-large, Prof. R. H. Fernald, Mr. G. R. Henderson.

"The above-mentioned nominees have all accepted their proposed nominations, and have expressed their willingness to serve if elected.

"No nomination has been made for the office of Secretary, in view of the change in the By-laws of the Club, by which this office is hereafter to be filled by action of the Board of Directors.

"Respectfully submitted on behalf of the Committee on Nominations,

(Signed) "EDGAR MARBURG,
"Chairman."

The Banquet Committee announced its plans and the speakers for the banquet.

The President stated that consideration was being given to the subject of establishing an Engineer Officers' Reserve Corps for the Army, and a Naval Coast Defense Reserve, by the Committee on Public Relations.

The paper of the evening, entitled "Hunting Big Game in Alaska with a Movie Gun," was presented by Mr. Howard W. DuBois, consulting mining engineer.

A unanimous vote of thanks was extended to the speaker.

The meeting adjourned at 9.45 P.M.

LEWIS H. KENNEY,
Secretary pro tem.

REGULAR MEETING OF THE BOARD
OF DIRECTORS

MARCH 13, 1917

The meeting was called to order by President Carter at 8.15 P.M., with Vice-presidents Yarnall and Andrews, Directors Murray, Wagner, Crampton, Bullens, Past Presidents Taylor, Swaab, and Ledoux, Secretary Fernald, and Treasurer Irish in attendance. Vice-president Vogleson and Director Gibson were excused. Directors Liversidge, Temple, Bachman, and Cassell were absent.

The minutes of the Regular Meeting of February 13, 1917, as issued to the Board of Directors, were approved.

REPORT OF THE PRESIDENT

The President stated that he and Mr. Yarnall, chairman of the Committee on Membership, were taking up the matter of the personnel of the Committee on Increase of Membership, which would be announced later.

A report was read from Mr. William H. Connell, who represented the Club at the American Road Builders' Congress in Boston.

Action: Report accepted, and the Secretary instructed to extend to Mr. Connell the thanks of the Board.

The President announced that, in connection with the matter of the extension of the private dining-room, the papers were ready for signature of the President and Treasurer, and the work would be started immediately.

REPORT OF THE SECRETARY

The following resignations from members in good standing were presented:

Charles W. Denny	W. B. Kugler
H. L. Duhring, Jr.	Malcolm C. Ludlam
Robert B. Ely	H. J. Moyer
Horace D. Enderiss	H. S. Munro
Walter R. Fox	C. M. Parker
J. Morton Fultz	Eugene S. Pleasonton
R. W. Griswold	Adam W. Reid
Caspar W. Haines	Wm. C. Rommel
Barton Hoopes, Jr.	W. C. Solly
J. E. Hunt	George Warner

Action: Resignations accepted as of March 31, 1917, with the understanding that should any reconsiderations be received before the end of the fiscal year membership will be continued.

The *Committee on Engineering Coöperation* requested that a delegate be appointed to attend a conference March 29 and 30, 1917, to be held in the rooms of the Western Society of Engineers, Chicago, Ill., the principal business of the Conference being to receive a report of the subcommittee on Engineering Coöperation.

Action: President authorized to appoint a delegate to this Conference, if there should be a member of the Club who expects to be in Chicago at that time.

It was announced that Mr. Edward H. Cahill, member in good standing of the Philadelphia Section of the American Society of Mechanical Engineers, had been elected

to Active membership in the Club, February 16, 1917, in accordance with the By-laws.

The Secretary brought up the question of entrance fee, and recommended that in the case of applicants who apply for membership prior to the adoption of the new By-laws the old entrance fee apply, even though the election take place after the adoption of the new By-laws.

Action: Recommendation approved.

REPORT OF THE BUSINESS MANAGER

The present By-laws transfer Juniors at the age of twenty-five years to Active membership, this transfer taking place at the beginning of the fiscal year. The new By-laws make the transfer age twenty-seven years.

Action: The Board rules that the transfer age will be twenty-five years for all who reach twenty-five years of age prior to March 20, 1917, and twenty-seven years of age thereafter, if the new By-laws are adopted on March 20.

Article VII, Section 1 of the By-laws, states that "Each Active member shall pay, within thirty days after notification of election, an entrance fee of \$25; otherwise, the election shall be void."

Action: It was the sense of the Board that the By-laws, as amended, be interpreted to mean that the \$25 entrance fee be paid when a man is either elected to Active membership or transferred to Active membership.

It was announced that, in accordance with the authority granted by the Board of Directors, an order was placed with the Whitehead and Hoag Company for 100 Club emblems.

The Board at its previous meeting ruled that the charge to non-Affiliated Societies for the use of the motion-picture machine should be \$15. It is recommended that the charge for the use of the machine to Affiliated Societies be \$7.

Action: Recommendation approved.

The opinion of the Board is desired as to whether or not it is advisable to retain counsel for the collection of our delinquent house accounts.

Action: It was the sense of the Board that the Business Manager use his discretion in this matter, authority having been granted by a former Board.

The Board of Directors, at its meeting, October 18, 1911, adopted the following:

"It was moved and carried that the credit of all members of the Club be absolutely limited to \$50, except that the room rent of permanent residents of the Club house be not included in this amount."

It is requested that the Board make a similar ruling on the subject of room rent.

Action: The Board ruled that the credit of all members of the Club be limited to two months' room rent.

It is requested that the Board define the question of exchange privileges. We announce on our membership card that we exchange privileges with certain organizations, and members of those societies frequently call at the Club to learn the extent of these privileges.

Action: The matter was referred to the House Committee for such action as they may deem desirable.

William H. Rau requests permission to make a photograph at our banquet. There will be no charge to the Club for this privilege, but the members may purchase photographs directly of Mr. Rau. I think a photograph of this sort will be needed for the members if we desire to obtain some special publicity.

Action: The matter was referred to the Committee on Banquet, with power to act.

REPORT OF THE TREASURER

The Treasurer presented a statement of the financial condition of the Club.

Action: Report accepted.

REPORT OF THE COMMITTEE ON FINANCE

The Chairman presented, for the Board's approval, the budget for the fiscal year April 1, 1917, to March 31, 1918, and stated that each member of the Board would later receive copies of the budget.

Action: After discussion, the Board decided that no action be taken on the budget until the next meeting of the Board, with the understanding that copies of the budget would be sent to each member of the Board for a further study.

REPORT OF THE COMMITTEE ON HOUSE

The Chairman reported that during the month of February 2725 meals were served, or an average of 97 per day. He also reported that, owing to the great increase in cost of supplies, the price of table d'hôte lunches and dinners, beginning March 15, would be raised to sixty cents.

Action: Report accepted.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The Committee presented a report, recommending that the following be elected:

To Active Membership:

Edward R. Armstrong	Peter P. G. Hall
Herbert K. Bear	George W. Herman
Percy D. Brown	Roy L. Hutchison
Carl F. P. Carrier	Stanleigh O. Kelley
Fred F. Chapman	Jacob M. Noll
Charles G. Cope	Karl R. Peters
Clement E. Crowley	Lewis M. Thompson

To Junior Membership:

W. H. Shuster, Jr.	George C. Wheeler
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Action: Recommendation approved.

REPORT OF THE COMMITTEE ON PUBLICATION

The Committee submitted the following report:

Suggested that the title of the publication be changed to the "Journal of the Engineers' Club of Philadelphia," or the "Engineering Journal," published by the Engineers' Club of Philadelphia; that the date for receipt of copy had been advanced from the twentieth to the fif-

teenth of each month, in order that the publication may be issued on the first of each month; that the secretary to the Committee was instructed to write to the Affiliated Societies, requesting them to furnish the Committee with papers presented before their meetings for publication in the PROCEEDINGS; and that the May issue of the PROCEEDINGS would be descriptive of the technical educational institutions in Philadelphia and vicinity.

Action: Report accepted.

REPORT OF THE COMMITTEE ON PUBLICITY

The Committee submitted no report.

REPORT OF THE COMMITTEE ON LIBRARY

The Committee submitted no report.

REPORT OF THE COMMITTEE ON PAPERS

The Committee presented a report, stating that it had become necessary to cancel the meeting of March 20, at Witherspoon Hall, owing to the inability of General Goethals to be present on that evening. The meeting would be held at the Club on that date, and Mr. Howard W. DuBois would present the paper of the evening on "Hunting Big Game in Alaska with a Movie Gun."

Action: Report accepted.

REPORT OF THE COMMITTEE ON MEETINGS

The Committee submitted no report.

REPORT OF SPECIAL COMMITTEES

Committee on Public Relations

The Committee submitted no report.

Committee to Secure Club Manager

The Chairman reported that, if the By-laws are approved, the Executive Secretary will not be appointed until the Board meets for organization in June.

Action: The Board requested the Chairman to continue, if possible, the present arrangement with Mr. Kenney for the conduct of the business of the Club until July 1, 1917.

Committee on By-laws

In order to avoid any confusion resulting from conflicts between the new and old By-laws, should the proposed amendments be adopted on March 20, the Chairman of the Committee on By-laws presented a set of resolutions to cover any possible points of interference between the present By-laws and the new until a complete reorganization can be made, in accordance with the new By-laws.

Action: In accordance with the suggestions of the Chairman of the Committee on By-laws, the Board adopted the following resolutions:

"WHEREAS, Certain amendments to the By-laws of the Club are now before the members for adoption or rejection at the Business Meeting to be held Tuesday, March 20, 1917; and

"WHEREAS, Article IV of the proposed amendments provides for certain changes in the number, terms, and duties of officers and committees differing from the number, terms, and duties provided for in Article IV of the present By-laws; and

"WHEREAS, Both the present and proposed By-laws provide that officers 'shall hold office until their successors have been duly elected and qualified'; therefore be it

"Resolved, That, if the proposed amendments be adopted, the present officers of the Club remain in office until their successors are duly elected and qualified, as provided for in the proposed amendments, and perform the duties designated for them to perform in the present By-laws. And be it further

"Resolved, That the committees appointed under the present By-laws be continued with the duties and powers conferred upon them until their successors are appointed at the Organization Meeting of the incoming Board, as

provided for in Article IV of the proposed amendments. And be it further

"Resolved, That the offices of Assistant Secretary and Business Manager as provided for in Article IV, Sections 6 and 8 of the present By-laws, be continued until July 1, 1917.

Committee on Club Development

The Chairman presented a form of contract, to be signed by the President and Treasurer, for the alterations and additions to the private dining-room.

Action: Report accepted.

Committee on Club Banquet

The Chairman reported that the notices had been issued for the banquet on March 30.

Action: Report accepted.

The meeting adjourned at 10.30 P.M.

ROBERT H. FERNALD,
Secretary.

Positions Vacant

Those in need of competent and experienced men will find it to their advantage to make their wants known through these columns. The Secretary of the Engineers' Club is constantly in touch with men capable of filling positions in all branches of Engineering. No charge is made for this service.

Engineer skilled in handling of materials, having had experience with conveying machinery and other mechanical means of handling and transporting materials, to study the handling of materials at plants of large industrial corporation. Apply Engineers' Club, No. 128—A.

Heating and ventilating engineer to study heating and ventilation and various similar problems at plants of large industrial corporation. Apply Engineers' Club, No. 129—A.

Combustion engineer to study combustion and boiler efficiency at plants burning bituminous and anthracite coal, plants ranging in size from 200 to 75,000 h.p. Apply Engineers' Club, No. 130—A.

Mechanical engineer who has had several years' mechanical experience, preferably in chemical industries, to investigate

mechanical problems arising in the operations of a large industrial concern. Apply Engineers' Club, No. 131—A.

Combustion engineer, experienced in power plant and stoker operation; familiar with modern instruments. Apply Engineers' Club, No. 135—A.

Mechanical Engineer.—Young man wanted with knowledge of electricity to take charge of 12,000,000-gallon pumping station. Apply Engineers' Club, No. 136—A.

Young engineer wanted as "outside man" by a well-established machine shop and foundry. Must have enough mechanical knowledge to solicit contracts for general machine work. Familiarity with heavy chemical machinery would be a great advantage. Apply Engineers' Club, No. 137—A.

Positions Wanted

Graduate structural engineer, two years' experience, desires position with engineering and contracting concern in Philadelphia. Apply Engineers' Club, No. 131.

Mechanical engineer, B.S. in M.E., University of Pennsylvania, 30 years of age, eight years' shop and business experience, wants to become connected with an established firm, giving part or full time, where technical knowledge and business ability are required. No sales proposition, experimental development, inspection, or boat-building work preferred. Best reference; want responsibility; will furnish bond if required. Apply Engineers' Club, No. 132.

Sales engineer, ten years' experience, desires situation. Apply Engineers' Club, No. 134.

Experienced sales engineer would like to locate with a responsible manufacturing concern. Apply Engineers' Club, No. 135.

Graduate Civil Engineer, 33 years old, with eleven years' experience in construction of dams, reservoirs, and water-works plants, is desirous of obtaining position where reliability and intentness of purpose are recognized factors. References furnished. Apply Engineers' Club, No. 137.

Engineers' Club of Philadelphia

COMMITTEE ON MEMBERSHIP

D. ROBERT YARNALL, Chairman

CANDIDATES FOR MEMBERSHIP

Members having knowledge of the candidates are invited to submit to the Committee on Membership before April 9th a confidential expression of opinion as to the eligibility of the candidates; all communications to be addressed, "CHAIRMAN OF THE COMMITTEE ON MEMBERSHIP, ENGINEERS' CLUB, PHILADELPHIA," marked "CONFIDENTIAL." All applications are on file at the Club and can be referred to by any member.

ALDEN W. BALDWIN

1243 S. 53rd St., Phila., Pa.

Instructor in Mechanical Engineering, Towne Scientific School, University of Pennsylvania.

Proposed by George E. Crofoot, J. V. Stanford and R. H. Fernald.

A. JULES BETUS

4928 Chestnut St., Phila., Pa.

Assistant Superintendent, The Philadelphia Rubber Works Co.

Proposed by Robert J. Bonstein and H. W. Thompson.

MORRIS BRADT

P. O. Box 95, Camden, N. J.

Mechanical Superintendent, Castle Kid Company.

Proposed by Frank H. Schaefer and Otho C. Roff.

JOHN E. DOLBOW

1424 S. 51st St., Phila., Pa.

Estimating and handling contracts, H. W. Johns-Manville Co.

Proposed by Issachar Murray and Clark Dillenbeck.

WALTER A. FLEISHER

Main and Rector Sts., Phila., Pa.

Manager, S. B. & B. W. Fleisher, Inc.

Proposed by D. Frederick Schick and Jos. D. Israel.

LEIGH PARTRIDGE HOFF

809 Stock Exchange Bldg., Phila., Pa.

Local Manager, The Baker-Dunbar-Allen Company.

Proposed by H. P. Gant and H. W. Thomson.

GEORGE G. HOFFMAN

1220 S. Edgewood St., Phila., Pa.

Construction Engineer for Combustion Engineering Corporation.

Proposed by H. W. Thomson, C. Harrington and Robert J. Bonstein.

JAMES T. HOLMES

123 N. 50th St., Phila., Pa.

Electrical Engineer, Scofield Engineering Co.

Proposed by Fred. B. Barns, R. Wharton Moorhouse and C. J. Walton.

ROBERT B. KRAUSS

911 S. 60th St., Phila., Pa.

President and Chemical Director, Hydrocarbon Chemical Products Co., Cardington, Pa.; Chief Chemist, Henry Phipps Institute.

Proposed by Robert J. Bonstein and Edward E. Krauss.

JOHN F. MCCOY

6358 Sherman St., Phila., Pa.

Sales Engineer with Schütte & Koerting.

Proposed by George A. Richardson, Howard S. Worrell and Arthur L. Collins.

L. WEIMER MURRAY

1520 Real Estate Trust Bldg., Phila., Pa.

Member Engineers' Society of Pennsylvania.

Representative, General Refractories Company, Philadelphia.

Proposed by George H. Chadwell and L. P. Kellogg.

HARRY C. NAGLE, JR.

3018 N. Broad St., Phila., Pa.

Chemist with the Barrett Company, Chemical Dept., Frankford.

Proposed by Robert J. Bonstein and H. W. Thompson.

WILLIAM D. RUDY

411 Walnut St., Phila., Pa.

Chemist, partner in Smith, Rudy & Co.

Proposed by W. S. Giele and Henry Hess.

FORREST R. SMITH

Glenolden, Pa.

Estimator, R. R. Hammond & Co.

Proposed by R. R. Hammond and Edward M. Bassett.

NOAH B. SMITH

411 Walnut St., Phila., Pa.

Chemist, partner in Smith, Rudy & Co.

Proposed by W. S. Giele and Henry Hess.

JOHN H. TROSS

1402 Widener Bldg., Phila., Pa.

Manager, Philadelphia office, Pittsburgh Bridge and Iron Works.

Proposed by C. V. Woodward and J. H. M. Andrews.

JOHN WILLIAM VAN ALST, JR.

3332 Smedley St., Phila., Pa.

Electrical Engineer, specification writer, Bell Telephone Company of Pennsylvania.

Proposed by George McKay, Jr., James P. McKay and Charles H. Schaefer.

EDWIN M. WENTZ

818 De Kalb St., Norristown, Pa.

Chemist, Diamond State Fibre Company.

Proposed by Robert J. Bonstein and H. W. Thompson.

HENRY W. WETJEN

1418 Pennsylvania Bldg., Phila., Pa.

District Sales Manager, Alberger Pump & Condenser Co.

Proposed by F. F. Kauffmann and Fred E. Doran.

FOR ELECTION TO JUNIOR MEMBERSHIP

WALTER P. SMITH

1516 E. Berks St., Phila., Pa.

Draughtsman, New York Shipbuilding Company.

Proposed by John H. Nuttall and James S. Malseed.

FOR ELECTION TO ARMY AND NAVY MEMBERSHIP

MAJOR CURTIS W. OTWELL, U. S. A.

Municipal Bldg., New York City.

Major, Corps of Engineers, U. S. A.; Inspector-Instructor, Engineer Troops, New York, Pennsylvania and Ohio.

Proposed by J. H. M. Andrews and J. S. Bradford.

"Vim, Vigor and Victory"*

By S. M. SWAAB

PAST PRESIDENT, CHAIRMAN CLUB DEVELOPMENT COMMITTEE

MANY years ago, during the Presidential campaign of Benjamin Harrison, I had the pleasure of accompanying my brother on a stump-speaking tour in this vicinity. At the time in question he was an attaché of the National Republican Committee and his function that of enlightening the public on the subject of the protective tariff. One evening, after he had delivered a very forceful and eloquent extemporaneous address on this subject, which was replete with figures representing our imports and exports, way up into the



millions of dollars, I inquired of him how it was that he could remember these figures so as to be able to give them correctly and in such minute detail, and he replied, "Well, if you do make a mistake of a few hundred millions of dollars, nobody is going to get up and correct you." It will be seen from this that it may not be absolutely necessary, when you are talking of the protective tariff, to quote figures cor-

rectly; but in the statement which I am to present here this evening on the part of the Club Development Committee, whatever I say will have to be taken for granted as having received some study, and, as I hope to give you the results of our deliberations with some degree of exactness, I will be obliged to beg your indulgence to read what I have to say on the subject.

I have been accorded the honor of presenting the new housing proposition to the membership, and, while this can be covered by a rather formal statement without any garnishings whatever and in non-technical language, it must not be forgotten that this statement is of, by, and for engineers, and therefore a most charitable view must be taken of it by non-engineers, if there happen to be any present this evening.

A member of the Engineers' Club, in attending the

First Annual Meeting, would have left his home and wended his way towards that of a fellow-member at whose home the meeting was to be held, for we had no regular meeting place in those days. Arriving at the meeting, he would have listened to, or perhaps taken part in, a discussion on the fourth dimension or some other equally abstruse scientific subject, or, possibly, if it just happened to be in the wind at the time, a discussion on some more utilitarian subject.

The Engineer, however, does more than take part in academic discussions. He is the virtual pathfinder, he is the trail-blazer, he is the most recently acknowledged pacemaker of the race, and, without question, he is to-day foremost in all things that affect its material advancement.

He, more than any other, can be likened unto Joshua of old, at whose behest we are told the sun stood still, or, on the contrary, when he bade it advance, it advanced, so much of a factor has he become.

During that dark period of the world's history, the Middle Ages, when the whole world stood still, or, worse, retrograded, the Engineer, as such, had not yet made his appearance; but it is since the time when the "Little Corsican" became the Emperor of the French that the Engineer has had the sway and has made his influence felt in all things that make for good and, consequently, for advancement. If I may be allowed to digress for a moment, the position of the Engineer in warfare to-day is acknowledged to be second to none, and more than at any other time in the world's history is this being daily demonstrated in the titanic struggle now raging in Europe. Modern warfare is recognized as an engineering problem, pure and simple (and this includes every phase of it), whether on land or on sea, and is solved by the usual methods which engineers employ.

It is therefore seen at a glance that engineering, constructive and destructive, is henceforth to be the biggest factor in the development of nations, and we are proud to be members of a profession which has this distinguished standing.

The Club has several times during the forty years of its existence shifted its meeting place, because, primarily, increases in its membership at various times warranted it, and also because the membership demanded better, larger and more commodious quarters.

The last move that we made, into a house in which we have some equity, was a very happy move, indeed, for it had that effect on the membership which, while largely

* Presented at 40th Anniversary Banquet, March 30, 1917, Bellevue-Stratford Hotel.

psychological, is no less real, that generally accompanies the possession of one's own home.

The recent affiliation of several kindred organizations with our own has rendered our quarters entirely inadequate, and new quarters or an extension of the present quarters is an absolute necessity. Extricating ourselves from the position in which we found ourselves after the affiliation, with an inadequate house and a depleted exchequer, seemed at one time to present insurmountable difficulties, and reminds one of the celebrated query of Mr. Dooley as to how a man is to get out of his trousers in a sleeping-car berth while he is sitting on them, but it is hoped that the scheme presented for your consideration this evening can be put over without embarrassing any one.

We wish at this time to present a comprehensive plan for the extension of the Club facilities, which, while it has not been worked out in all of its details, is, nevertheless, sufficiently well developed to exhibit its principal features.

I had occasion, a short time ago, to call the attention of the membership, through our CLUB PROCEEDINGS, to the fact that we should aim high, that we should aim to do something big in this connection, and I believe I went on to say at that time that even if we did not hit the bull's-eye, if the object of our search was large enough, we were bound to hit the target somewhere, while if our aspirations were on a smaller scale, we might miss the target absolutely.

We began our existence under not very auspicious circumstances, but, notwithstanding this, we propose to hand down to those who come after us a heritage of which both they and we shall rightfully be proud.

Beginning our existence as a Club with a membership of twenty-five or thereabouts, and at the present time possessing a membership of nearly twenty-five hundred, is in itself no mean achievement.

The present Club house, while it may not be considered to be located in the heart of the Club district in this city, is not sufficiently removed therefrom to cause serious objections on this score.

As the scheme for development must be worked out in several successive steps so as not to cause either physical or financial embarrassment to any one, we will proceed, after this brief preface, to consider it in detail.

Thanks to the efficient and conservative management of the Club affairs, while we cannot afford to be lavish, neither is it necessary for us to be niggardly, as we have, after a substantial probationary period, demonstrated that we have passed beyond the stage of unstable equilibrium.

In several points the present quarters are notably deficient, and it can be accepted without dispute that the dining-room and the attendant kitchen facilities, while ample for a Club of six hundred members, are sadly deficient for a Club four times that size.

This is no doubt the most notably deficient feature that appeals to the membership-at-large, but the management knows that increased lodging and auditorium facilities are just as necessary.

The present auditorium, capable of seating about two hundred, was more than ample when the Club membership was six hundred, but, since the phenomenal increase in our membership, has been unable to accommodate us, and it has been necessary for us to hold many of our meetings, at least those which were of a semi-technical nature, outside of the Club house. This has some advantages, but it also has its disadvantages, and the proper balance must be struck by weighing one against the other.

The statement that the possession of inadequate auditorium facilities might have its advantages must not be taken too literally. What is meant is simply that an adequate auditorium of a size to accommodate a maximum audience would occasion very heavy construction and carrying charges such as might not be justified by the use which we have for an auditorium. There is no question of the fact, judging from our experience of the past year, that an auditorium seating about four hundred will be adequate for all our purposes. On extraordinary occasions we may still be required to secure a public auditorium.

Having pointed out the insufficiency and the deficiencies of the present Club house, it is my purpose to describe one which is thought to be adequate for all our needs on all ordinary occasions.

Because it is difficult to divorce ourselves from our usual methods of thinking, it is not unnatural that we should apply, so far as that may be possible, the principles of the art we practice, even in such commonplace matters as those in which we are now concerned. Engineering has been defined by former Chief Engineer McHenry, of the Northern Pacific Railway, as the "Art of making a dollar earn the most interest." If this be conceded—and there is no question of its correctness—then, in designing Club quarters for an aggregation of engineers, economy of construction and operation must be a fundamental principle, if not the paramount consideration.

Our Club is rich in numbers, and has always maintained a very high standard of professional proficiency in its membership, but there is no gainsaying the fact that our financial resources are to be reckoned with. It follows, therefore, that we must provide a place the cost of maintenance of which will be well within our capacity to support, and, in fact, the latter consideration is the only limit to the amount of money we are justified in spending. For this reason we feel that we can accomplish considerably more at this time, for the membership-at-large, by using the present quarters as a nucleus than by abandoning this establishment for a larger and more costly and elaborate one which might possibly saddle carrying charges on the Club not only incommensurate with the advantages to be derived therefrom, but also beyond our reasonable ability to support.

If what is herein stated is taken to be true in whole or in part, then the natural method for us to pursue is to acquire property adjacent to our present quarters and develop and improve it in such a manner as to increase

the present facilities which are now either wholly lacking or in which notable deficiencies exist.

The Committee has in mind securing the premises immediately adjoining the Club on the east (No. 1315 Spruce Street) and subsequently transforming this into a suitable addition to the present Club quarters.

A brief description of the contemplated improvements made possible by acquiring the adjoining property is as follows:

The most apparent demand at this time is for enlarged dining-room accommodations, with corresponding kitchen and serving facilities. It is proposed to combine the dining-rooms of the two buildings by means of a one-story structure built on the yard, thereby increasing our seating capacity about 150 per cent. and resulting in a much better lighted dining-room than at present. As increased dining-room capacity is of little value without corresponding kitchen and serving-room facilities, a new and commodious serving-room will be built on the yard, permitting the space now occupied for this purpose to be utilized as a part of an enlarged kitchen, the floor area of the latter being increased about 50 per cent. In the yard space between the two buildings and under the same roof will be built a one-story office adjacent to the new dining-room and serving-room of such size as to accommodate the entire clerical force under the Secretary, and also the editorial staff of the journal. This arrangement will relieve the present library of any possible encroachment, and, best of all, will restore the very desirable room, now occupied as an office, to increase the sleeping quarters, which are now lacking.

Next in importance, and almost as urgent, is a more spacious auditorium. This can be provided by removing the party wall between the two buildings, and thus increasing the present auditorium by utilizing the corresponding rooms in the adjacent property. The new auditorium will accommodate approximately four hundred persons, with ample aisle space, besides providing for a liberal-sized rostrum on the east side of the building. A notable feature is that two stairways will be available, and can be used independently, if so desired, for purposes of entrance and exit.

The third demand, and by no means the least important, is increased and improved sleeping accommodations. The remaining space within the walls of No. 1315 Spruce Street can be economically converted into twelve sleeping-rooms with baths. Other conveniences resulting from the proposed changes are double the parlor, lobby, and lounging space on the first floor, with increased cloak-room space and basement toilet facilities, increased coal storage, and, if desirable, double the billiard-room and card alcoves.

The present steam-heating installation, slightly augmented, it is thought, has sufficient boiler capacity to heat the new building. Considerable unoccupied yard space with entrance on Irving Street on the rear of the two properties could be utilized for garage or other revenue-producing purposes.

A very commendable feature of the entire scheme is

that, approximately, 90 per cent. of the work through the various processes from demolition to final completion can be accomplished without in any way disturbing the everyday use of the present Club house, and if it can be arranged to cut the openings and make the necessary restorations incident to bringing about the actual connection between the two properties during the summer, the members need not suffer any inconvenience whatever.

In line with the scheme for centralization of the engineering interests in Philadelphia, in which our Club has heretofore been the principal figure, there is no question of the fact that this can be carried still further with all of the attendant good results which have been accomplished thus far and possibly in a more marked degree. The Franklin Institute of Pennsylvania, so well known throughout the country as a scientific organization of the first grade, is preparing to build on the line of the Parkway. To secure a site adjacent to that of the Institute should, in the opinion of the Development Committee, be the aim of our organization. If, within the next ten years, the affairs of the Club warrant more spacious quarters, we might build a Club house on this property, and by some arrangement with the Institute we might be able to use its auditorium and its library, which, by the way, is one of the largest and most complete technical and scientific libraries in the country, thus conserving space and capital outlay on our part in return for certain privileges which the Institute might exact of us in return. There is little doubt that the future will see the center of the institutional and communal life, and possibly the business center also in this city, moving westward along the line of the Parkway.

In summarizing, it may be said that temporarily, at least, we should extend our dining-room facilities by utilizing the space now occupied by the conservatory, and a contract for this work has actually been signed and the work is being prosecuted, and we should also build in our present house at least two more baths or supply running water in each of the sleeping-rooms. This will tide us over until such time as it will be possible for us to invoke the next step in the process herein outlined, viz., the utilization of the adjacent premises as an addition to our present Club house, and, last, our removal to the Parkway, close by The Franklin Institute. While this latter step may be many years in the future, still it is the thought of the Committee at this time that provision should be made therefor.

Too much cannot be said regarding the advisability of proceeding immediately with this work. The Development Committee has secured at this time the withdrawal from sale, which is tantamount to an option on the property in question, for a period of ninety days, dating from March 1, and it is therefore seen that during the next two months it will be necessary for us to secure the wherewithal to purchase the property and also sufficient to make the necessary additions and alterations and also to provide adequate furnishings, and with

(Concluded on page 182)

Engineers' Club of Philadelphia

COMMITTEE ON PUBLIC RELATIONS

GEORGE R. HENDERSON, Chairman

THE ENGINEERS' CLUB: ITS SERVICE TO THE COUNTRY IN TIME OF NEED

At the time of any national crisis such as the present one, it behooves every one to render every assistance possible to the Government for the protection of the rights of American citizens. It is possible for a body of trained men such as the members of this Club to be of inestimable service. In line with this, the following correspondence and papers are self-explanatory.

Hon. Woodrow Wilson, February 21, 1917.
President of the United States,
Washington, D. C.

DEAR SIR:

Permit me, on behalf of the Engineers' Club of Philadelphia, to pledge to you the whole-hearted, loyal support in any emergency that may arise from your stand for the maintenance of the rights of the United States of America.

This Club, with its 2500 members, representing all branches of engineering, numbers among its membership many men who might be of service to the Government. Rather than take a canvass of our membership to determine in what particular line each member feels best equipped to serve, I thought it wiser to ascertain first in what lines, if any, the Government might need assistance of the Philadelphia Engineers. We therefore have the honor of awaiting your instructions.

Very respectfully,

EBC-G (Signed) EMMETT B. CARTER,
President.

Dr. Hollis Godfrey, February 21, 1917.
Member of the National Defense Committee,
Drexel Institute, Philadelphia, Pa.

MY DEAR DR. GODFREY:

At a meeting of the Engineers' Club last night it was the general sense of the members present that the Engineers' Club should go on record as pledging their support to the Government in the present crisis; and, in accordance with their desires, I am to-day sending a letter to the President, copy of which is enclosed herewith.

It is not our intention or desire to annoy the Government with offers of service when none is needed; but if there is anything we can do, we are only too ready to undertake it; and, as I happen to know that you have been putting considerable time on this very matter recently, I should be very glad to get your advice before the Club goes further into the matter.

Very truly yours,

EBC-G (Signed) EMMETT B. CARTER,
President.

THE WHITE HOUSE

MY DEAR SIR: February 23, 1917.

The President asks me to acknowledge the receipt of your letter of February 21, and to say that he is bringing it to the attention of the Secretary of War.

Thanking you and your association for your generous assurances, I am

Sincerely yours,

(Signed) J. P. TUMULTY,
Secretary to the President.

Mr. Emmett B. Carter, President,
The Engineers' Club of Philadelphia,
1317 Spruce Street, Philadelphia, Pa.

WAR DEPARTMENT

OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON

Mr. Emmett B. Carter, President,
The Engineers' Club of Philadelphia,
1317 Spruce Street, Philadelphia, Pa.

SIR:

1. Receipt is acknowledged of your letter of February 21, 1917, addressed to the President, and it is desired to thank you for your generous offer for service. Your letter has been noted for reference in case of need.

2. It is believed that you may be interested in the Engineer Officers' Reserve Corps, which affords a means whereby patriotic individuals desirous of serving the country can, in time of peace, prepare themselves to render efficient service and at the same time enroll so that the War Department can be in a position to call upon those best suited for the work in hand.

3. Information circular and blank application for commission in the Engineer Officers' Reserve Corps are sent herewith for your information and use should you so desire. Information regarding the Enlisted Reserve Corps is also forwarded, with the thought that you may be able to interest therein others who may not be qualified for the Officers' Reserve Corps.

By direction of the Acting Chief of Engineers.

Very respectfully,

(Signed) C. V. RIDLEY,
Captain, Corps of Engineers.

ENGINEERS' CLUB OF PHILADELPHIA

Form No. 163, W. D., Engineers.

INFORMATION CONCERNING APPOINTMENTS IN THE ENGINEER OFFICERS' RESERVE CORPS

1. The Officers' Reserve Corps is authorized by sections 37-40, 49, and 51-53 of the National Defense Act approved June 3, 1916.

2. The regulations prescribed by the President to carry the same into effect are published in General Orders, No. 32, War Department, July 28, 1916, which also quotes in full the above mentioned sections of the National Defense Act.

3. The following extracts from the above general order give the principal requirements of the regulations that apply to the Engineer Officers' Reserve Corps. A copy of the complete regulations will be furnished on request, which should be addressed to the Chief of Engineers, United States Army, Washington, D. C.

4. Applicants commissioned in the Officers' Reserve Corps will rank in the various sections according to grades and to length of service in their grades. Commissions will be issued for periods of five years. No age limits apply to the Engineer Officers' Reserve Corps.

5. Except as otherwise herein provided, a member of the Officers' Reserve Corps shall not be subject to call for service in time of peace, and whenever called upon for service shall not, without his consent, be so called in a lower grade than that held by him in said Reserve Corps. In time of actual or threatened hostilities the President may order members of the Officers' Reserve Corps, subject to physical examination, to temporary duty with the Regular Army, or as officers in volunteer or other organizations that may be authorized by law, or as officers at recruit rendezvous and depots or on other duty. They may be promoted to vacancies in volunteer organizations or to temporary vacancies in the Regular Army, as prescribed in the Act. While Reserve officers are on such service they shall be entitled to the pay and allowances of the corresponding grades in the Regular Army.

6. Department commanders and the Chief of Engineers, when authorized by the Secretary of War, may order Reserve officers of their departments or corps to duty with troops in the field or at field exercises or for instruction for periods not to exceed 15 days in any one calendar year. While so serving such officers shall receive the pay and allowances of their respective grades in the Regular Army. These periods will not be extended except with the consent of the reserve officers concerned.

7. Enlisted men of the Regular Army and of the National Guard, both active and retired, if citizens of the United States, are eligible for examination for commissions in the Engineer Officers' Reserve Corps. No applicant will be examined who is an officer of the Regular Army on the active list or of the National Guard or who is not a citizen of the United States.

8. The examining board will ordinarily be composed of one officer of the Corps of Engineers, one member of the Engineer Officers' Reserve Corps, and one officer of the Medical Corps or the Medical Officers' Reserve Corps.

9. The mental examination of no applicant will be undertaken who, in the judgment of the board, is not physically qualified to discharge in active service all the duties of an officer of the grade in which the applicant seeks a commission in the Officers' Reserve Corps; nor of any one who has any mental infirmity or deformity of body, or whose moral fitness has not been duly established.

10. No person shall be examined for appointment in the Engineer Officers' Reserve Corps unless he has a letter from the Chief of Engineers authorizing his examination. Such a letter to an applicant will be the acknowledgment of the receipt of his application.

11. If an applicant has served in the Regular Army of the

United States, or in any of the Volunteer forces of the United States, or in the Organized Militia of any State or Territory, or the District of Columbia, he shall submit his discharge papers for each term of service; if still in service of any of the organizations named, he shall submit recommendations of his immediate and higher commanders.

12. If an applicant has attended or pursued a regular course of instruction in any military school or college of the United States, or has graduated from any educational institution to which an officer of the Army or Navy has been detailed as superintendent or professor pursuant to law, he shall, if a graduate, be required to present a diploma or certificate of graduation from such military school, college, or educational institution, or, if not a graduate, a certificate showing the amount and character of training, theoretical or practical, satisfactorily completed thereat.

13. Every applicant will be subjected to a rigid physical examination which shall include the ordinary analysis of the urine, and if there be found to exist any cause of disqualification which might in the future impair his efficiency as an officer, he will be rejected. Defects of vision resulting from errors of refraction which are not excessive, and which may be entirely corrected by glasses, do not disqualify unless they are due to or are accompanied by organic disease.

14. Candidates for appointment in the Engineer Officers' Reserve Corps will be examined either (a) for duty with combatant Engineer troops or other duties in the service of the front, or (b) for special service on the lines of communications or other points in rear, including Engineer work in connection with sea-coast defenses, as hereinafter indicated. Officers appointed under (b) will not ordinarily be assigned to combatant duties but will be subjected to such assignment whenever needed. The examinations shall be especially directed to ascertaining the practical capacity of the applicant, and the record of previous service and training of the applicant shall be considered as a part of the examination.

Military experience or training in the Regular Army, Volunteers, or National Guard, or at training camps or educational institutions will be noted and reported by the board and considered in making the recommendations.

A. QUALIFICATIONS FOR RESERVE OFFICERS, SERVICE OF THE FRONT.

1. For First and Second Lieutenants.

(a) The applicant must be an engineer in the active practice of his profession or some business immediately connected with, or concerned in, engineering matters.

(b) He must either hold or have qualified for the grade of junior engineer, civil, electrical, or mechanical or higher grade in the civil service, or he must be a graduate from an approved engineering college, or have been in the active practice of engineering for at least two years.

2. For Captains.

(a) The applicant must be an engineer in the active practice of his profession or some business immediately connected with, or concerned in, engineering matters.

(b) He must either hold or be eligible for the grade of assistant engineer in the Engineer Department at large, or a corresponding engineer grade in the civil service in another department of the Government service, or have held a commission in the Corps of Engineers of the Regular Army, or shall be a professional engineer not less than 28 years of age, who shall have been in the active practice of his profession

for at least eight years and have had responsible charge of work as principal or assistant for at least two years. The graduation from a school of engineering of recognized reputation shall be considered as equivalent to two years' active practice.

(c) Knowledge of the principles of military organization and operations, as illustrated in Infantry Drill Regulations, Parts I (to include School of the Company) and II, and Field Service Regulations, Part I and Part II (Articles I, II, IV, VI); and of the general principles of field fortifications, as illustrated in the Engineer Field Manual, Chapter V.

3. For Majors.

(a) The applicant must be an engineer in the active practice of his profession or some business immediately connected with, or concerned in, engineering matters.

(b) He must hold the grade of assistant engineer in the Engineer Department at large, or corresponding engineer grade in the civil service in another department, or have held a commission in the Corps of Engineers of the Regular Army not more than two grades below that for which he desires to be listed, or shall be a professional engineer not less than 35 years of age, and shall have been in the active practice of his profession for 15 years, who shall have had responsible charge of work for at least five years, and shall be qualified to design as well as to direct engineering work. Graduation from a school of engineering of recognized reputation shall be considered as equivalent to two years of active practice.

(c) In addition to fulfilling the qualifications given in paragraph 3 (a) and (b), the candidate will be required to pass an examination on the following subjects:

Drill Regulations, Parts I (School of the Company and Battalion only), II, III, Infantry Drill Regulations.

Field Service Regulations, entire text.

Duties of Engineer officers and troops in war, as illustrated in the Engineer Field Manual and Bulletin No. 4, Volume I, of the Office of the Chief of Staff.

Coöperation between the various arms of the service, as illustrated in "Technique of Modern Tactics" (Bond and McDonough), Chapters VIII, IX, XI, and XII.

All examinations will be oral.

B. QUALIFICATIONS FOR RESERVE OFFICERS, SPECIAL SERVICES.

Candidates desiring appointment in special services must be qualified for at least one of the duties assigned to the Corps of Engineers by the following extracts from Army Regulations:

"1493. The duties of the Corps of Engineers comprise reconnoitering and surveying for military purposes, including the laying out of camps; selection of sites and formation of plans and estimates for military defenses; construction and repair of fortifications and their accessories; * * * the installation of electric power plants and electric power cable connected with seacoast batteries; * * * construction and repair of military roads, railroads, and bridges; military demolitions; * * * In time of war within the theatre of operations it has charge of the location, design, and construction of wharves, piers, landings, storehouses, hospitals, and other structures of general interest, and of the construction, maintenance and repair of roads, ferries, bridges, and incidental structures, and of the construction, maintenance, and operation of railroads under military control, including the construction and operation of armored trains."

No oral or professional examinations will be required, but recommendations of boards will be required in lieu of such examinations. Candidates will submit evidence of their actual employment in corresponding or higher positions in civil life and references to persons under whom they have been or are employed.

Reserve officers from the following civilian occupations will be required for the special services of the Corps of Engineers:

Bridge engineers.

Constructing engineers (earth and concrete).

Constructing engineers (wharves, piers, and buildings).

Electrical engineers (for small plants and power lines).

Highway engineers.

Mining engineers (skilled in tunneling and use of explosives).

Railroad engineers (construction and maintenance).

Railroad operating officials.

Sanitary engineers.

Topographical engineers.

WAR DEPARTMENT.

OFFICE OF THE CHIEF OF ENGINEERS,

Washington, August 1, 1916.

Letter of Application for Examination for Commission in Engineer Officers' Reserve Corps.

....., 19.....

THE CHIEF OF ENGINEERS, U. S. ARMY,

Washington, D. C.

SIR: I have the honor to apply for examination for a commission as ¹..... of Engineers, in the Officers' Reserve Corps, organized under the authority of Congress.

I have served years in ².....

I have pursued a regular course of instruction for years in ³.....

I graduated in the year from ⁴..... after having creditably pursued the course of military instruction therein provided.

I was born, 1....., and am ⁵..... a citizen of the United States. My business is

My experience is

My membership in engineering societies is as follows ⁶.....

I enclose letters of recommendation and addresses of three citizens who know me, as follows:

.....
.....
.....

Respectfully,

Permanent P. O. address:

The correctness of the statements above made was sworn to and subscribed before me, 19.....

⁷.....

¹ Insert grade, first or second lieutenant, captain or major.
² Insert service in Regular Army of the United States, or Volunteer forces of the United States or Organized Militia of any State, Territory, or District of Columbia; also state in what capacity. See par. 11 of Form No. 163.
³ Insert name and location of the school or college.
⁴ Insert the name and location of the educational institution. See par. 12 of Form No. 163.

⁵ Insert "not" if in accordance with fact.
⁶ If a member of an engineering society, state society and grade of membership.
⁷ Oath to be taken before, and signature to be made by, officer authorized by law to administer oaths.

WAR DEPARTMENT.

ENGINEERS

FORM No. 163a

Authorized Dec. 15, 1916.

(Continued on page 187)

The Engineers' Club and the United States Naval Reserve Force

ON January 9, 1909, The Engineers' Club took its first active step toward aiding the country in what has since come to be known as "Preparedness," by the organization, from among its members, of Company "B," Engineers' Battalion, N. G. P. Now its members are in the forefront in the organization of the Naval Reserve Force.

Five of its members—Harold Goodwin, Jr., John I. Rogers, F. M. Gardiner, George E. Lawrence, and Walter A. Hall—were enrolled among the first and rank in the order named. The first two have received the provisional rank of Lieutenant and the others the rank of Lieutenant (junior grade), all in the Naval Coast Defense Reserve.

Lieutenant-Commander F. R. Payne (retired), executive officer of the United States Naval Home in this city, is responsible for the preparation of the first two. Due to his early work, they are the first officers appointed to the Reserve. They also feel indebted to Lieutenant J. H. R. Cromwell (U. S. N. R. F.), who was receiving instruction with them under Commander Payne. Lieutenant Cromwell took the class off for cruises on his motor yacht *Nedeva*, so that they were able to get practical work to supplement their studies.

Lieutenant Goodwin is a member of the Engineering Staff of The Philadelphia Electric Company. Lieutenant Rogers is treasurer and chief engineer of the Eagan-Rogers Steel and Iron Company, Crum Lynne, Pa. Lieutenant Gardiner is a member of the Engineering Staff of Day & Zimmerman. Lieutenant Lawrence is president and engineer of Barrett & Lawrence, marine engineers. Lieutenant Hall is sales manager in the New York district for the Yale & Towne Manufacturing Company.

The Naval Reserve Force consists of six classes. The first three classes are for men with naval or mercantile marine experience. Class Four, the Naval Coast Defense Reserve, is that to which an ordinary landsman is eligible. It consists of persons capable of performing special useful service in the navy or in connection with the defense of the coast. Such service may be aboard coast-defense vessels, torpedo craft, mining vessels, patrol vessels, and particularly aboard yachts and motor boats suitable for naval purposes in the defense of the coast. These are usually known as the "Mosquito Fleet."

All engineers, particularly mechanical and electrical engineers, can undoubtedly be of great service in this class. Many officers are required on shore duty in the navy yards and with smaller craft who would be liberated for service with the active fleet were there a large reserve of citizen engineers who could take up their duties in these positions. The members of the Club should consider seriously this opportunity to serve the country.

In connection with the "Mosquito Fleet" and land stations, the Naval Department will need a large number of wireless operators, and those who are expert enough to send and receive at ordinary commercial speeds should enroll at once. The radio-work on ships is particularly pleasant and should appeal to expert operators.

The Naval Reserve Force differs from the Officers' Reserve Corps of the Army in that the former covers all enlisted ranks as well as officers.

Members of the Club may therefore do a service by encouraging the enrollment of men whom they can influence for any work of which they are capable either at sea or on shore.

Independent of the Reserve Force, the Naval Training Association of the United States is conducting weekly meetings for instruction aboard the battleships at League Island. There is no obligation to serve in the navy in joining this association, and yet it affords one a good opportunity to discover whether he would be capable for service in the Reserve Force and obtain training to fit him for such service.

The Naval Training Association last summer conducted a cruise for its members, and should conditions permit, it is the intention to continue this every year. It is best described as a "Naval Plattsburgh." Last summer the Atlantic Reserve Fleet was assigned for this cruise. Nine ships carried the Volunteers from the various ports, the Philadelphians being on the flagship *Rhode Island*. The cruise was most enjoyable and instructive, and should improve every year.

The Engineers' Club congratulates Lieutenants Goodwin, Rogers, Gardiner, Lawrence, and Hall on their appointment. May many other members of the Club be led to follow their example and thus actively take up preparation for the defense of this country!

The Zoning System *

WHAT is done in one city is not usually a pattern for another city, and the work in limiting building heights and in zoning in New York City will not, in every particular, apply to a great round city like Philadelphia. Congestion in New York City is affected by its geography, the East and Hudson Rivers, bounding Manhattan on either side, having confined the growth of the city.

What was the problem confronting New York City? The skyscrapers were a considerable part of that problem.



HON. EDWARD M. BASSETT, ESQ.
CHAIRMAN, HEIGHTS OF BUILDING
COMMISSION AND OF COMMITTEE ON
BUILDING DISTRICTS AND RESTRICTIONS,
NEW YORK CITY

A building could be put up to any height, of any form, and cover the entire lot, regardless of the rights of neighbors or whether such a building rendered surrounding plots incapable of being improved by useful buildings or not. Buildings were erected to twenty and more stories in height, making the streets dark, so that artificial light had to be used along the narrower streets to the height of ten and twelve stories. It grew to be the fact that offices in the tall buildings could be rented better near the top, the lower floors being less and less desirable. The greatest evils were the making of "canyon" streets, the overcrowding of certain localities, and the stealing of light and air from one's neighbors. If in any block the first builder can erect a building to any height he chooses on the side lines, and can open his windows on those lines, the land adjoining has had its light absorbed. If any adjoining owner then puts up an equally high building on his property line, the rooms are dark, and, although he may have ruined the first building, he will himself be harmed, and there is no satisfaction to either.

Over and over again it has happened in New York City that the first building having windows overlooking

the adjoining unbuilt-on lot earned high rentals by reason of having the benefit of good light and air, yet, as soon as other buildings were erected on the vacant lots adjoining, the earning power of the first building decreased until to-day some of the poorest investments are the skyscrapers. There has been a great deal of misapprehension as to the earning power of skyscrapers in New York City. The increased cost of building them necessitates an investment constantly demanding more income to cover the increase in fixed charges. Elevators have to be built in gangs so that the upper stories may have suitable elevator service. The result is that some of the largest buildings in New York City are, as one architect has expressed it, "little more than gangs of elevators surrounded with a shell of offices." Many office buildings in Greater New York do not pay more than two and one-half or three per cent. on the investment.

The problem, however, was not limited to office buildings of the skyscraper class. Congestion from large tenement houses through the Harlem district along the backbone of Manhattan Island and extending across the Williamsburg Bridge into Brooklyn was another phase of it. In fact, the problem included even more than the congestion of tenements. A glue or chemical factory would invade almost any part of the city, driving away the surrounding residents and preventing buildings of the better class being built in such localities. The sporadic tenement house went up in detached-house or block-house localities, exploiting a neighborhood that had been built up under private restrictions. A premature tenement in an outlying district will often rent well, due to attractive suburban surroundings. It actually grew to be the case in New York City that a man was highly speculative who would erect a dwelling house costing over \$30,000 or \$40,000, because he had no assurance as to what, in the future, would come into the neighborhood or what would be built on his side lines. Residents, therefore, moved away to Long Island, or New Jersey, or Westchester County, to build first-class homes.

Fifth Avenue, the great retail street of the city, was gradually invaded by unsuitable uses. There was no limit to the heights of buildings. Owners on lower Fifth Avenue could erect a building fifteen, or even twenty-five, stories high and earn a better return than on a building of fewer stories. Up such tall buildings went until, finally, enough tenants could not be secured to fill them. People in the garment-making business were attracted to such buildings in such localities because there were lofts

* Special Meeting, Engineers' Club, January 26, 1917.



1. USE DISTRICT SHEET
 HEAVY LINES SHOW BUSINESS DISTRICTS RESTRICTED AGAINST INDUSTRY; OPEN LINES, RESIDENTIAL DISTRICTS RESTRICTED AGAINST BOTH BUSINESS AND INDUSTRY,
 AND DOTTED LINES INDICATE DISTRICTS UNRESTRICTED. NO UNDETERMINED DISTRICTS APPEAR UPON THIS SHEET.

to rent that could not well be rented to any one else. Such manufacturers also appreciated a Fifth Avenue address, and they wanted their workmen and their goods close together. There was an immigration of garment makers, especially white goods makers, to Fifth Avenue and the nearby streets. Then a queer thing happened. In the mornings at seven o'clock, again at noon, and then at six o'clock in the evening, Fifth Avenue was congested with garment workers walking to and from work or strolling at lunch time, until retail shoppers found they were crowded off the sidewalks. Rents decreased rapidly, the ground floors making the best earnings, and the value of land went down, in some cases to fifty per cent. of what it had been before the advent of the garment workers. There was a problem of an invasion of the great retail street of New York City by a use rendering it less desirable for its original use, and that invasion marched up Fifth Avenue until it reached the locality of the Waldorf. When the Zoning and the "Save New York" movements came, such use was arrested, and it is hoped upper Fifth Avenue will not only be preserved, but that the lower portion, to Madison Square, will gradually be redeemed.

Private restrictions are not a remedy. Many localities, both in Manhattan and the outlying boroughs, had practiced private restrictions. Original owners of large plats placed restrictions on all or part when sold, and such restrictions, having the one source, were considered binding upon all those deriving title from that source. Sometimes restrictions were against business only; sometimes against manufacturing, or against nuisances, or the selling of liquor. In the suburbs these restrictions brought about uniform set-backs from the street line, and sometimes the building of one-family detached houses. These private restrictions helped to build up splendid localities, but there were difficulties with them. When nearing the expiration of restrictions, vacant lots, especially on corners, tended to remain vacant, awaiting such time that they could be used for a purpose such as an apartment house or store, and so exploiting a fine residence neighborhood that the private restrictions had built up. Around the edges of these restricted localities, business or apartment houses, or factories, would be worked in, and, if the restrictions were perpetual, the courts would sometimes decide that there had been a change in the character of the neighborhood and that the perpetual restrictions were considered to have lapsed. Owners of vacant land would even restrict the first portions of large lots sold until a fair scattering of fine houses was assured, and then they themselves would sell the remainder at high prices, without restrictions, permitting the newcomers to exploit their neighbors by building business places or apartment houses. Private restrictions have thus acquired a reputation of not restricting. If Greater New York, as a whole, were left under the protection of private restrictions alone, as years go by there would be no visible effect

of such private restrictions upon the ultimate upbuilding of the city.

About four years ago, George McAneny, then president of the Borough of Manhattan, a nervy practical man with an imagination, proposed that something be done to bring about a harmonious method of building in New York City to prevent the continuance of these harmful invasions and the stealing of light and air by covering the entire area of a lot. The problem that immediately arose was the problem of the skyscraper, and the skyscraper was studied in an effort to prevent extreme heights and the erection of large buildings covering entire lots. The Commission appointed by the Board of Estimate took evidence on the subject for a whole year and studied the skyscraper from every angle. Statistics were gathered that were startling. Closely-packed buildings, buildings of unlimited height, were found to be injurious to the investor and to neighboring owners. Rules were formulated limiting the heights of such buildings to the street width or to some multiple of that width, and providing that such buildings might exceed the prescribed height only by a set-back from the building line. Towers were allowed because they lend interest to the buildings of any great city. It was found that making limits in the skyscraper district was but the beginning of the problem. To bring a remedy to one part of the city and to a certain sort of building would have effected only a partial cure. The favor of the courts could probably only be secured for a plan of which it could be said that every locality of substantially the same sort was treated in substantially the same manner. The Commission formulated a law, and that law was the beginning of zoning in New York City. The law was made a part of the City Charter and provided for an appointment, by the Board of Estimate, of the Commission on Zoning, to which commission were given all the police powers of the state of New York having to do with the height, size, area, and use of new buildings.

Work upon the zoning problem has been in progress for more than two years. The field was a new one of original work, as it was necessary to discover the class of buildings and to make types of buildings and then to find a method of making restrictions that would be fair and that would be suitable for an American city where the work must be done under the police powers of the state, and not by the mandate of rulers unbound by a written constitution. There was opposition; Mr. McAneny and his co-workers were styled "city beautifiers," and it was predicted that their work would have no practical chance of ultimate success and would make no headway inside of fifteen or twenty years.

Detailed maps were prepared for every borough, showing the allowable heights of buildings, the percentage of lots that could be covered by new buildings, and showing the use of new buildings. These maps were made street by street and block by block. The heights map showed the allowable heights of buildings following the prescribed



2. HEIGHTS DISTRICT SHEET

AREAS ARE MARKED OFF IN WHICH NEW BUILDINGS MAY BE ERRECTED ON THE STREET LINE TO A HEIGHT NOT IN EXCESS OF 1 1/2 TIMES OR 2 1/4 TIMES THE STREET WIDTH. ABOVE HEIGHT LIMIT ON STREET LINE, BUILDING HEIGHT MAY BE INCREASED IN A RATIO OF SET-BACK OF THE EXTENDED PORTION FROM THE STREET LINE.

rule. These heights were adapted to the various parts of the city. The area map provides for the percentage of lots to be covered, and the use map for the establishing of industrial, business, and residence sections throughout the entire city. There are five boroughs in Greater New York—Manhattan, The Bronx, Brooklyn, Queens, and Richmond—and of each of these boroughs maps have been prepared as the result of intensive study upon the ground, so that this great city is now fixed for its ultimate development and building, from the Yonkers line on the north to Tottenville, Staten Island, near Perth Amboy, on the south, and from the Hudson River to Flushing and Rockaway Beach.

Some one may say, "How can any city be run into a fixed mould on a restriction plan and not be allowed to grow? Everything growing requires changes." That is conceded. To provide for these changes, the law was amended to the effect that the people in any district may petition the Board of Estimate to make the alterations they desire, provided a public hearing on advertisement first be held, and also that, if twenty per cent. of the frontage affected protests in writing, the change could only be made by unanimous vote of the Board of Estimate. This method is actually working out to-day quite successfully, because, while it stiffens the plan—and the plan must have rigidity—it enables needed changes brought about by the development of the city to be made. The law was approved by the Board of Estimate on July 25, 1916, and has been received with much favor and unanimity by the people of the city. No class or trade or profession opposed the law. Bankers, title companies, insurance men, owners of vacant land, owners of skyscrapers, owners of old buildings, erectors of new buildings, fire department and health department officials, physicians, and all have given their united support. This has been brought about by four years of constant education and publicity and the holding of conferences. Three hundred conferences and hearings were held throughout the city, and gradually hundreds of citizens in the different boroughs became acquainted with the details of the plan and the law, so that when the matter came up for a final hearing before the Board of Estimate almost complete unanimity resulted.

Just previous to the final adoption of the zoning law, a movement arose in Fifth Avenue called "Save New York." This movement had extensive advertisement and was an attempt to bring Fifth Avenue back to its former high-class use. The merchants contributed to stop further harm to the avenue, and directed their efforts to transplant the garment factories occupying the lofts of high building to localities further south in the city. The movement has been very successful, and many factories have either moved away entirely or have made preparations so to do. Property on Fifth Avenue is now taking on new life and value which it has not enjoyed before, and, since the passage of the zoning law, the

stabilizing influence of that law has been felt throughout all of Manhattan. In the suburbs, residents do not avoid the expense of making additions or alterations, as they feel that the law now protects them indefinitely. There are renewed hopefulness and increase of values throughout the entire city. Business districts are protected against industry, and resident districts are protected against both industry and business. The factory and the public garage are no more the terrors they were five years ago.

When work was begun upon the zoning law, public garages did not seem to be harmful, but it was found, on investigation, that they were becoming one of the greatest detriments to property values in New York City, and they were finally prohibited in the residence and busi-

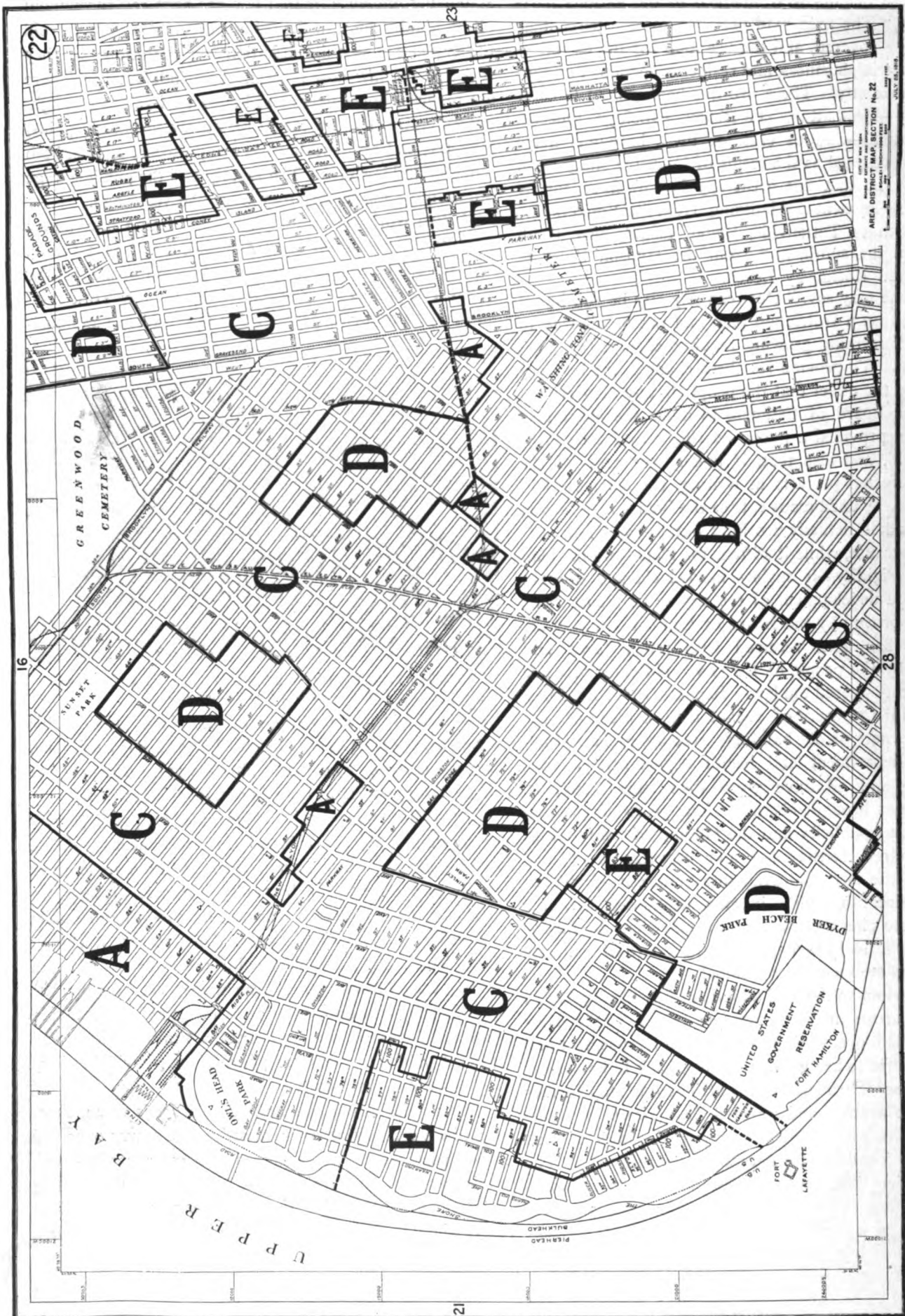


ILLUSTRATING PUBLIC GARAGE INVASION OF HIGH-CLASS APARTMENT HOUSE SECTION

ness districts and allowed in the industrial districts. This action alone seems to have justified all that has been done, because business places of high class and residences are saved from the blight of public garages next door.

All of the zoning work is done under the police powers of the state. The courts have been careful never to define police powers. They permit them to increase in their scope as the needs of humanity increase, as they are based on safety, health, morals, and the general public convenience. The maintenance of the zoning system in New York City rests now with the courts. Careful preparation, however, has been made, not only by the city, but by associations of private individuals, to see that the needs of the city, from a health, safety, and general public convenience point of view, will be fully placed before the courts.

As a great city grows and as new needs come, there must be a recognition of increased police power over and above what would be recognized as necessary when such a city was comparatively small. It is hoped that zoning work done along the line of the present needs of a modern city, where what is done is for the benefit of all and as a community act, will be considered a necessary and proper exercise of police powers.



3. AREA DISTRICT SHEET

IN A DISTRICT ENTIRE LOT FOR NON-RESIDENTIAL BUILDINGS MAY BE BUILT UPON. B AND C DISTRICTS PUT GREATER RESTRICTIONS ON AREAS OF LOT OCCUPIED. D DISTRICTS ARE INTENDED TO PRESERVE RESIDENTIAL SECTIONS FOR ONE- AND TWO-FAMILY DWELLINGS AND REQUIRE DOUBLE THE OPEN AREAS ALLOWED IN B DISTRICTS. THE E DISTRICTS ARE PRIMARILY FOR DETACHED AND SEMI-DETACHED HOUSES IN WHICH AT CURB LEVEL FIFTY PER CENT. OF LOT AREA ONLY MAY BE OCCUPIED. IN EACH AREA DISTRICT YARDS AND COURTS ARE DIMENSIONED PROPORTIONAL TO BUILDING HEIGHTS.

(Mr. Ford's paper was principally explanatory of slides exhibited, showing actual conditions in congestion of traffic in New York City, the breaking down of residential districts by other uses, the invasion into residential districts by business, the wiping out of set-backs in other portions of single blocks, and observations upon a series of maps forming part of the New York zoning law.)

IN dealing with the problem of zoning in New York City, we felt our first duty was to know the city intimately and in detail. Patience and persistence in this idea enabled us to prepare the complete use, height, and area maps which form part of the zoning law as now in force in the city.

The first step was mapping the city in detail, showing the use of buildings for residences, business, industrial, manufacturing and railroad purposes. Such maps were made for each block in the city. Again, the same detail



GEORGE B. FORD
CONSULTING ENGINEER
NEW YORK CITY

was shown for the heights of the various buildings throughout the entire city, and also another set of maps showed the portions of the lot occupied. In addition to these maps, a complete topographical map was made, showing by contour lines the various levels, and the park land; also the gradients of the different streets, so that we might know what streets were adapted for heavy traffic and therefore principally usable only for commercial purposes. Another

map showed the time zones of the new rapid transit system, calculated from the City Hall as a center to all parts of Greater New York. Areas within ten, twenty, thirty, and more minutes were separately shown. Such maps indicated the comparative accessibility of each point in the city to the City Hall, and a large part of the districting, with regard to the intensity of the occupation of land, was based on this map. Still another map showed the use of streets for trucking or for automobile traffic, and indicated the relative density of traffic upon different streets. Such a map would show the relative importance of travel from a traffic point of view, and might indicate where business would be located to follow such lines of travel. A base map of the street system was also prepared, upon which the final plans were developed. Another map indicated the boat and railway terminal facilities throughout the city. From such a map the manufacturing, industrial, and warehouse districts could be located to place them



ORIGINALLY PRIVATE RESIDENTIAL SECTION; TRANSFORMATION TO APARTMENTS; AND INVADDED BY GARAGE—OPPOSITE A PUBLIC PARK

in close communication with transportation facilities. A map also showed the streets already physically opened and where opening proceedings were under way, so that streets already available for use were indicated, and also those not at present available but for which plans could be made for opening in the future. Another map showed the entire metropolitan district of New York, including Staten Island, which comprises an area of 327 square miles, and for that area 111 separate district maps are now available for use, height, and area limitations for every street and every block.

Tentative district maps were first prepared, and the final regulations for districting were formulated by a policy of elimination. These tentative maps were published in March, 1916, and were spread broadcast throughout the city. The newspapers explained them in great detail. As a result of this campaign of education, a strong public opinion was built up in regard to the system which actually insisted that the regulations laid down by the Commission upon these tentative maps should be made more drastic. The final maps were adopted by the Board of Estimate and Apportionment on July 25, 1916. In some of the area districts, notably in Brooklyn, property owners in large numbers petitioned the Board to increase the areas of the E zones, the district of



SHOWING INVASION OF RESIDENTIAL DISTRICT AND AVOIDANCE OF SET-BACK

minimum occupancy, so that in some cases such districts covered five times the original area mapped. In Flatbush, in the use map, the people demanded that a great many business streets be changed to residential streets, despite the fact that by so doing walking distance to the business streets would be considerably increased, in many cases making a walk of a mile to the nearest store. In the heights district maps there are several hundred buildings existing to-day that are higher than the new limitations permit. In the lower part of Manhattan there are nearly a hundred of such buildings. A new building built to-day on the site of the Equitable Building, which is 36 stories high, could only be built to a height of 16 stories. Such limitations upon the height of this character of building were based on the testimony of property owners and real estate men that such tall buildings rarely pay.

Since the zoning law became effective on July 25, 1916, many demands for changes were anticipated, but the number of such demands have been astonishingly



SHOWING CONGESTION ON BROADWAY, NEW YORK, NORTH FROM TRINITY CHURCH, AT NOON HOUR

small, and the larger portion of the petitioners asked that certain restrictions be made more drastic. As the law stands to-day it seems well able to defend itself.

WE have listened with great pleasure to the gentlemen who have come from New York to enlighten us. They speak from experience; we can only speak in anticipation. The complexity of the problem confronting any set of men undertaking to bring out of chaos such order as has been done in New York seems at first staggering. I endorse what both Mr. Bassett and Mr. Ford have said regarding New York conditions. A suit that would fit New York might not fit Philadelphia or Washington. The conditions of life, of business,



GEORGE E. DATESMAN
DIRECTOR, DEPARTMENT PUBLIC
WORKS, PHILADELPHIA

of industry, and the social conditions vary so much in different cities that each city must be studied entirely from the standpoint of its own characteristics. We resemble the original New York Commission in that we are also fearful of our steps and hesitate to make any radical expressions of opinion. One member of the Commission stated that he had to take the entire Commission on board a boat so as to be where the members could not get

away from him, and for a whole day argue with the individual members to impress them with the importance of the undertaking on which they had em-

barked. He said he succeeded only because he had them corralled on shipboard.

Every time I have heard about the work of the New York Zoning Commission it has been for my instruction, and what impresses me most, as a member of the Philadelphia Commission, is the magnitude of the problem we have before us. The popular view would be that when we begin to interfere with so-called individual rights we at once invite opposition. We have an idea of liberty on this American continent, and especially in the United States, that is very different from the idea of liberty in a monarchical form of government. Municipal matters are controlled by government abroad; in this country we feel that each individual is a government unto himself. When a man here buys real estate he feels it is his right as a citizen to do with it as he pleases. The examples that have been shown us of the awakening of individuals and whole communities to the view that the individual must be lost in the community interest in order that he may protect himself are proved by the New York law, and with proper publicity in Philadelphia we will find that individual independent planning will be superseded by planning in the community interest.

If individual property owners, operative builders, and real estate men could know the effect upon their holdings of a multiplication of similar buildings about them and the consequent depreciation of values and earning power, they would come to believe that a 40-foot-wide street should not be used for a 15- or 20-story building.

One of the principal things that has been forced upon us in Philadelphia is the encroachment of the public garage and various kinds of business upon residence districts. Such invasions have become nuisances and have acted as a detriment to real estate and rendered values insecure in such neighborhoods. Our operative builders

are beginning to appreciate the importance of building regulations, for the Commission is in almost daily receipt of applications for relief.

Philadelphia is a peculiar city, spread out in many directions and with heterogeneous buildings scattered over the entire area. The peculiar topography of the city, also, cut up as it is by railroads in all directions, raises many economic municipal problems. If restricted areas can be established for industries, the railroad lines and main heavy traffic avenues could be concentrated so as to make for economy in public expenditures.

The regulation of the height of buildings is not so

important here as in New York, use being of first importance and the area of lot built upon being for second consideration. The Philadelphia Commission, organized but recently, has already done considerable preliminary work, and we have been encouraged by the statements made by Mr. Bassett and Mr. Ford as to the practical work accomplished in New York and the encouragement that has been given to the project by the public. If the public here will support this project, worked out for its own interest, rather than place obstacles in the way of its accomplishment, the result should be a successful building up of a greater and better city.

It is always a comfort to hear men from New York City tell us of something in that city really worth copying, because for years New York has been the great example of what not to do. New York's "Model Tenements" are vastly inferior to Philadelphia's two-story, single-family houses, and yet one Philadelphia philanthropist was so impressed by New York's tenements that he actually built such a tenement here to show us what to do. Not long ago Mr. Lawrence Veiller said: "New York's Model Tenements are merely purgatory,



PHOTO BY PHOTO-CRAFTERS
ANDREW WRIGHT CRAWFORD
SECRETARY, ART JURY
PHILADELPHIA

as compared with the hell they used to have; they are nothing like the heaven you have in your Philadelphia two-story, one-family houses," of which we have 225,000.

In this matter of zoning, New Yorkers showed the way of approaching the subject. They did not, however, establish the first precedents, for Los Angeles and Boston have that honor. Boston led off by districting itself into two height-limit districts. One hundred and twenty-five feet was

fixed in the central district, and 80 feet everywhere outside of that district, and that zoning regulation was upheld by the Supreme Court of Massachusetts and the Supreme Court of the United States. Los Angeles determined upon a residence district, but the owner of a big clay deposit in that district proposed to make bricks from the clay on his own property. He claimed he had a vested right to do that, but the people of Los Angeles thought differently. The Police Commissioner was about to enforce the regulation, whereupon the clay owner brought an action to restrain the city from enforcing that

regulation. The Supreme Court of the United States upheld the decision of the Supreme Court of California that a city has the right to protect the interests of the city and its citizens even against a vested interest, so that this power of districting is one that can be exercised under the Constitution of the United States. It is, however, a power that must be exercised reasonably; such regulations cannot be unreasonable.

In the E zones of New York it is proposed to have 70 per cent. of each lot free from buildings, and that is a big advance over what obtains in Philadelphia. Where the ordinary two-story, single-family house is built on a minimum lot 14 feet front by about 41 feet in depth, a flat rule requires 144 square feet of the lot to be unoccupied. This regulation holds irrespective of the frontage or the depth, and for the minimum-sized lot it figures 25 per cent. of the lot left unoccupied. This means that outside the street lines the ordinary two-story house in Philadelphia—the workman's house—is built 45 houses to the acre. If we adopt the E zone principle of but 30 per cent. of lot to be built on, 45 houses to the acre will be reduced to 20 houses per acre. It is magnificent that New York City had the courage to put such a regulation into force. It is hoped we may even do better for the outlying sections of Philadelphia. I do not see why, ultimately, what has been done in England for 18,000,000 working men and their families under the Housing and Town Planning Act of 1909 should not be accomplished here. Under that act, garden cities and garden suburbs to the number of about 58 have actually been built, and in those cities and suburbs the average is 12 houses to the acre. The city of Minneapolis has done somewhat better even than that, for in the residential section, except in the center of the city, houses have been built only six to the acre. Under the new regulations to be put in force in Philadelphia, we may do even better than New York has done by keeping houses for the workmen to, say, 12 to the acre, considering there are so many more workmen than capitalists and the capitalists can look out better for themselves. If we do not improve upon the New York law, we shall have lost a great opportunity.

With regard to developed sections, there are many peculiar situations. At a particular location in Philadelphia, on one corner stands a branch public library; on another corner, a five-story apartment house; on the third corner, a private residence, and just beyond the open lot on the remaining corner is a very artistic church building. It is stated that it is now proposed to build an oil or gasoline structure on the fourth corner, and the attorneys for the oil company state that the structure will be unobjectionable, because it will be "artistic." If that structure were an oil tank values in that neighborhood would depreciate at once and the city would also lose in tax revenue. When values go down, assessments for taxation go down with them. The city's income goes down, and the borrowing capacity is likewise reduced; so that, in this matter, the city's income for current purposes and its borrowing power for permanent improvements are both involved, as well as the values of private interests. With regard to areas already occupied in the built-up sections of the city, we cannot do much; but, as in New York, in regard to all three subdivisions, height, use, and area built upon, individual studies must be undertaken and individual blocks investigated completely and carefully, one by one.

With regard to occupancy, the central portions of the city should not be used for heavy manufacturing purposes. Residential districts should be created in order to prevent various things that are not regarded as nuisances at common law. With regard to height, I agree generally with Director Datesman, but am not quite sure that the question of height limitation is less important than the question of use. Use is not as important as the area of lot to be left open, because the latter is so intimately related to the public health that any Supreme Court Justice could not fail to say that this directly concerns the police power. In England, figures show that life in the garden suburbs is vastly more healthy than in cities. In Philadelphia the death-rate is 15 per thousand; in English garden suburbs and cities it is about 5 or 6 per thousand, and I have similar statistics available as to the effects on the height and weight of growing children. It seems to me, therefore, the matter of the portion of the lot to be left open is the most important thing to be taken up.

Next in importance is the question of the limitation of the heights of buildings in the central area. We are absolutely up against that proposition to-day. The Chestnut Street "canyon" is becoming darker with the erection of each new building, and it is time for us to take vigorous

steps to prevent more darkness, more dampness, and more unhealthy conditions. There is a considerable area around City Hall, between it and neighboring buildings, and in that locality the standard already set by the Wanamaker and Widener buildings may be accepted, and therefore it may be tentatively suggested that the height limitations for the area, say from the west side of Thirteenth Street to the south side of Arch Street, and from the east side of Fifteenth Street to the north side of Chestnut Street, may follow the Wanamaker and Widener standards. Elsewhere, the maximum should be the Boston and Scranton maximum, which is 125 feet.

The central business area will be limited to some extent by the loop proposed for the transit system. I do not think the effect of that loop will be good. Chicagoans say that the transit loop has frightfully throttled the development of the city. In the central loop there is no question we will find the great business area of the city. There may also be a traffic circuit bounded by Locust Street, Seventh or Eighth Street, Race Street east of Broad Street, Arch Street west of Broad Street and perhaps Sixteenth Street. The business area will undoubtedly extend as far as the Delaware River, so that the central business area of Philadelphia in the near future will be defined by Seventeenth Street, the Delaware River, and Spruce and Vine Streets, and there will be a tendency to push that area west to the Schuylkill River. This can be controlled to some extent. In that area some multiple of the street width should be adopted for the building height. If Chestnut Street be taken as 60 feet wide, buildings should be permitted to twice that height, or 120 feet, which will include a building of about 11 stories. On certain wider streets, greater heights may be permitted, but in general a maximum height of 125 feet should be determined upon. Individual blocks should be studied for individual lower maximum heights.

Outside of the central area, the maximum height should be fixed at 80 feet, as in Boston. The advantage of that limitation is that it has already been upheld by the Supreme Court of the United States. In many sections of Philadelphia we might safely adopt the standards of English, German, and French cities for a height limitation varying from 60 to 75 feet.

We have a great opportunity here in Philadelphia, and the problem must be carefully studied. What is done will affect the city, its growth and the health of its inhabitants vitally for generations to come, and therefore we must have courage and not fear to pioneer even in legislation.

"VIM, VIGOR AND VICTORY"

(Continued from page 168)

the slogan, "Vim, Vigor and Victory," in the campaign which it is proposed to inaugurate, there is no question of our carrying out the plan as outlined.

There is no question, also, of the fact that if this plan is considered adequate and is acceptable to the Club-at-large, and if the campaign is pushed vigorously and with as much vim on the part of all concerned as was displayed in the campaign for increase of membership in November of 1915, victory will be assured.

Amendments to the Rules and Regulations of the Bureau of Health

OF THE CITY OF PHILADELPHIA, GOVERNING HOUSE DRAINAGE
ADOPTED JANUARY 15, 1917

Resolved, That the following amendment be added to the Rules and Regulations of the Board of Health governing plumbing, house drainage, etc.:

Rule 21 (a). "Every garage or other structure having a water supply, either of a temporary or permanent character, used for the housing, sale, or repair of automobiles, or in which automobiles are washed, cleaned, or repaired, shall be provided with a means of drainage for the floors and repair pit in such manner as will prevent the flow of drainage therefrom over streets, alleys, or paved approaches. The drainage from the floors and the repair pit shall be conducted to an intercepting pit, which shall be ventilated by extending a ventilating pipe of at least 4 inches in diameter to at least 2 feet above the roof, and it shall be provided with an air inlet opened to the outer air. This intercepting pit shall be of a design approved by the Bureau of Health and shall be water-tight, built of brick laid in cement mortar, or of concrete, and shall be so arranged as to intercept all oils, gasoline, or other fluids, as well as sand, silt, or other solids, for the purpose of excluding the same from the sewerage system. It shall be provided with one or more 24-inch cast-iron manholes and covers, and shall be located so as to be easily accessible for cleaning.

"Every garage or other structure, either of a temporary or permanent character, used for the housing, storing, or sale of automobiles, or in which automobiles are washed, cleaned, or repaired, shall be equipped with adequate means for continuous ventilation."

Resolved, That Rule 33 of the Rules and Regulations of the Board of Health governing plumbing, house drainage, etc., be amended to read as follows:

Rule 33. "In all buildings having house drainage systems, there shall be a main vertical soil or ventilating pipe not less than four inches in diameter; except in old buildings where the fixtures consist of a sink and bathtub only; then the waste or ventilating pipes may be not less than two inches in diameter, provided that such building is not more than four stories in height."

Resolved, That Rule No. 40 of the Rules and Regulations of the Board of Health governing plumbing, house drainage, etc., be amended to read as follows:

Rule 40. "All waste pipes, except refrigerator waste pipes, shall be directly connected with the drainage system."

Resolved, That Rule 59 of the Rules and Regulations of the Board of Health governing plumbing, house drainage, etc., be amended to read as follows:

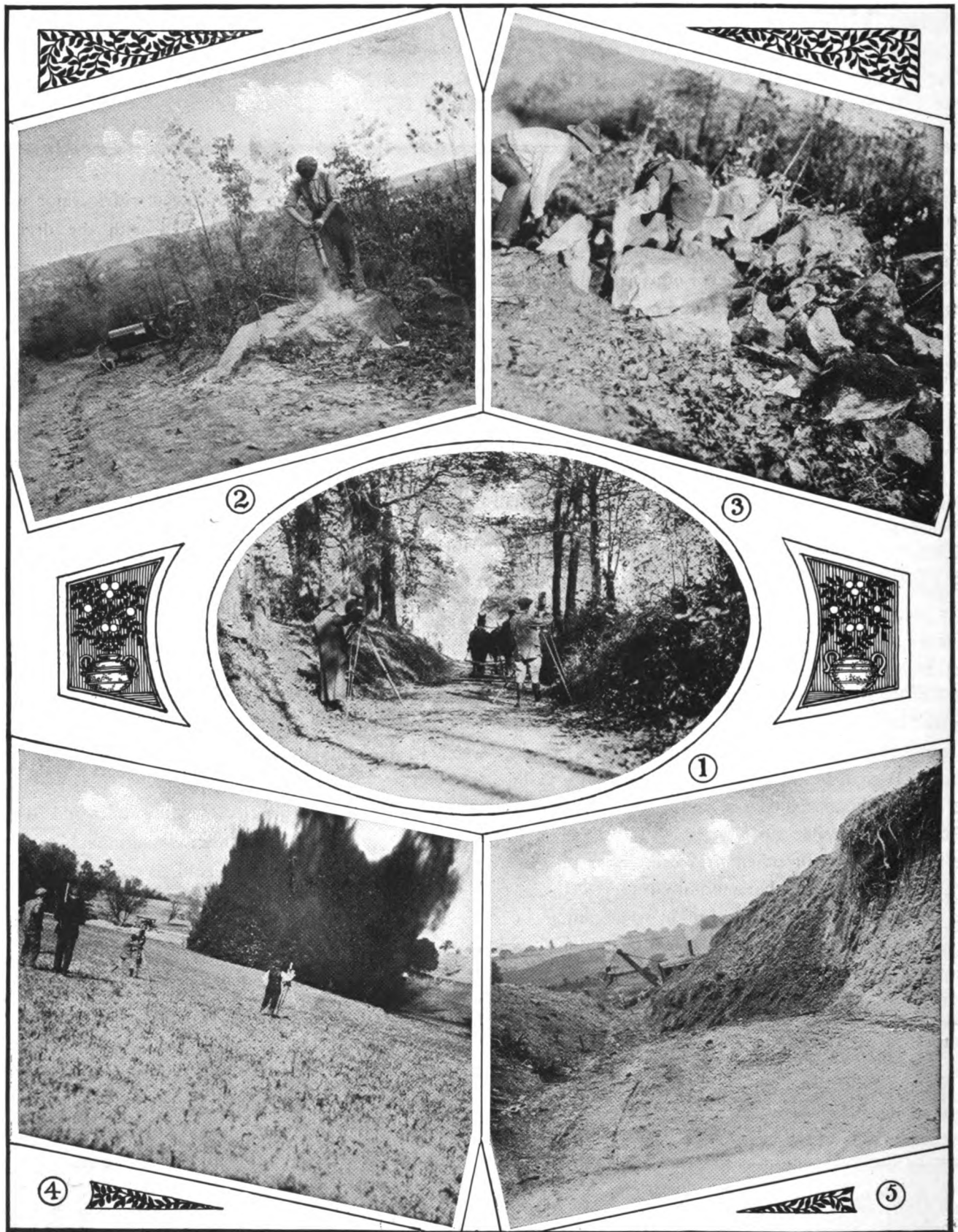
Rule 59. "No air inlet shall be used at the rear end of a system of drainage. When a water-closet is connected with a drain pipe and located in the cellar or basement, in the rear of a soil or vent pipe which extends to the roof, there shall be a separate vent pipe not less than two inches in diameter, which shall extend to the roof, as required for soil and ventilating pipes. Small-fixture waste pipes, exclusive of water-closets or slop-sinks, not to exceed four, may be connected to the said two-inch line of pipe, providing the building is not more than four stories in height. If a water-closet is to be connected, then the pipe shall be not less than four inches in diameter. In buildings five or more stories in height, the sizes of the soil, waste, and vent pipes shall be as provided in Rules 35 and 36."

Resolved, That Rule No. 22 of the Rules and Regulations of the Board of Health governing plumbing, house drainage, etc., be amended to read as follows (effective January 1, 1918):

Rule 22. "The main house drain and all of its branches, irrespective of whether laid above or below ground, shall be plain, extra heavy cast-iron pipe, with well-leaded and caulked joints, from a point ten feet outside of the foundation wall to the extreme end of the system.

"All other drain, soil, or vent pipes shall be plain, extra heavy cast-iron pipe where laid under ground, and where above ground, they shall be of plain cast-iron, galvanized steel, galvanized wrought or brass pipe of the weights prescribed.

"For buildings in which acid water is used, the pipes of the drainage system shall be of such material as shall be approved by the Board of Health upon special application."



SCENES IN THE MAKING OF THE DU PONT ROAD BUILDING FILM.

(1) MAKING THE PICTURE; (2) DRILLING A DANGEROUS BOULDER PREPARATORY TO BLASTING; (3) THE SAME BOULDER AFTER THE BLAST; (4) FIXING THE STREAM FOR BETTER ROAD DRAINAGE; (5) WIDENING A NARROW AND DANGEROUS CUT IN HIGHWAY.

ROAD BUILDING*

By Dr. J. H. SQUIRES

OF E. I. DU PONT DE NEMOURS & COMPANY, WILMINGTON, DEL.

IN our contact with the engineering fraternity, on roads, we find that there is too much tendency to look at road building absolutely from the standpoint of the main connecting highways and boulevards. I do not want in any way to criticise the building of through roads—wide-gauge roads, some of them thirty or forty feet—but I do want to bring out the point that the greatest percentage of our roads to-day are earth roads, and that the same statement will be true fifty years from now.

Enumerating the actual mileage of roads means very little. We must have, in connecting our big cities, enormous roads, every bit of them hard metal. As to what that "metal" will be is a matter that must be determined, in many cases, in the near future, because every change that is made in traffic changes our road conditions. You will find no better example of that in the world than the old Shenandoah Turnpike, built in 1833. It was so good a road that in the 60's, during the Civil War, locomotives of that day were dragged over it without materially injuring the road or the locomotives. The water-bound metal would not stand, and they came to tar. The through traffic of the North and South going over that road is raveling it from one end to the other. They will make another change to some more durable or stronger material. Later on they may have to pull that up and go to something still better.

In addition to the connections of the cities, towns, and villages in our most densely populated areas, it is necessary for us to throw the main highways across the continent in every direction. They have bearings from all standpoints—the standpoint of pleasure, the standpoint of trade, and I do not think any one will contradict me when I say that they will eventually have a very important military bearing. These are conditions that we see very largely from the highly-developed communal standpoint, where we have the densest populations to move. The trunk roads and city roads do not serve anything like forty per cent. of the population of the United States. They must depend entirely on their little by-roads and country roads. At best, at present, they can be but gravel or water-bound macadam. Most of them will remain earth roads. Some may have a light dressing.

In making each stage of the development from the actual wood road on through the different steps of progress, we can achieve a great saving in actual expenditure of money if the first locations and the plans have been made and work done so that it will become a part of

any improved road that may follow. We have beautiful examples of that all the way through; but, ordinarily, every change in road calls for a new location. That means new grading and dressing. In fact, everything must be new. A little attention paid to following the logical lines of travel will cut down the trouble and expense of relocation.

I do not want to talk at any length on any of these subjects, but to take up some points that are fundamental. I believe that it is an old axiom of engineers that water is the worst enemy of a road. I should like to put the statement in another way. Good drainage is the first essential of road building. Roads are built exactly like railroads. They follow either the valley or ridge lines. The high lines lead across the country at the easiest possible grades at high levels, or follow the low levels of the foot hills. The valley roads follow the streams. In practically all our old roads we have found that the hill roads have tended to stay a little bit too close to the top of the ridge, rather than follow the easier contour around the sides. That was the case in the time of my grandfather, and that is exactly what we are doing to-day. We find the same condition in old valley roads—that the easiest place to clean up a grade was along the bank of the stream. Incidentally it is the hardest place of all to drain, because the recent alluvium has a very strong affinity for water. The mechanical absorption is so great that it immediately resolves itself, in any show of rain, to mud. Where these roads were located back from the first bottom or along the bench, they found much easier grading.

With location made with a view to drainage and ease of haul, each change in actual width of the road or reduction of grade can become a part of a complete boulevard, despite the fact that this road may be a single-track road. We do not know just when we will be called upon to break that road through and make it one of the main lines of travel, and perhaps a connecting road between two states.

Another and very important feature that is causing much trouble is the matter of road width. We find, from one coast to the other, many road locations that must remain single-track roads, and which require an enormous expenditure of money. On one of the transcontinental roads—across the state of Montana—I had to go fifteen miles to find a place in the road wide enough to turn a 112-inch wheel-base automobile around. A very slight change in the location would have permitted a 16-foot, 18-foot, or even a 20-foot road, at no great increase in

* Regular Meeting, Engineers' Club, February 20, 1917.

first cost. In many cases it seemed that they suddenly picked up a contour and followed it around.

The next proposition, in watching our roads develop, is the one of constant attention to drainage. I think there is no better example of poor road drainage than you will find in the roads built in Mecklenburg County, North Carolina. They were building hard metal roads when many others considered them an idle dream. They used a good foundation, a good surface, a good bottom course, but despite the fact that they were going through a rolling country, absolutely naturally drained, they paid no attention to side and outfall ditches. Now practically that entire system of roads—all the original roads—has gone. Many have been rebuilt once or twice—some of them three times. Some time ago I was riding over a piece of this North Carolina road I have just mentioned, in very wet weather. It was a double road and I could not tell whether I was on the hard metal or the soft dirt; the wheels were down to the hubs. Practically every one of those conditions could have been prevented by very slight patrol duty. Many times one hour spent in keeping adequate drainage ways open would do more good in maintaining a road than any amount of money spent in repairing the hard metal. In some cases it is a matter of state, county, or district supervision.

Another matter is the question of where we should drive. Just as soon as we get over the shoulder of the road we begin to pull over pieces of the metal, and I do not except any metal—the hardest concrete, the reinforced and all of them, are being chopped off, not entirely by trucks, but very largely by the shock of rapidly-moving pleasure cars. The remedy is to keep on the metal yourself and insist that the other man keep on the metal. It sounds like going a little out of the way to bring that up, but it is one of the features that we must observe in maintaining our highways.

The expense of building roads is something appalling. A few weeks ago I was talking to the Highway Commissioner of the state of New Jersey, which, as you know, is a comparatively small state. He made the positive statement that for the improvement and surfacing of the roads of that state alone will require at least four millions of dollars. They do not intend to do it all next year. In other states the cost will be far greater.

Regarding changes in conditions, we are having to change our methods on practically all types of road work. Not long ago practically everything was done by hand. Fifteen years ago all the grading and ditching was done by hand. The change in this condition was brought very forcibly to my mind on a Pennsylvania road the other day. A little fellow who was working on the road said, "I gotta \$1.25 a day; I carry de water; I heat de pipe." He was the same boy who but a little while ago we had on the road for 30 cents and 40 cents and at the outside 50 cents a day as the water-boy. One dollar and a quarter at that time was very good pay for many of the men on the job. On this recent job I think the cheapest man, that was classed as a man, was on the pay-roll at \$2.35. We also have an increased tonnage of earth, stone, and other material to move, and it becomes necessary that we make the most careful and detailed study of the methods, machinery, and different appliances, in order to make it possible to reduce the amount of hand labor required.

(Moving-picture films exhibited, showing difficulties encountered in attempting to traverse poor roads; the slow, laborious, and expensive way of building roads by hand labor, contrasted with the time, labor, and expense saved by the use of up-to-date methods, assisted by explosives; various means of preparing the surface of roads and the ease of rapid travel over a well-built road.)



SPREADING
ROAD TAR IN
RESURFACING
A BADLY WORN
ROAD

(Continued from page 171)

WAR DEPARTMENT

THE ADJUTANT GENERAL'S OFFICE

WASHINGTON

March 16, 1917.

OFFICERS' RESERVE CORPS CIRCULAR.

Provision is made in the National Defense Act of June 3, 1916, for the formation and maintenance of an Officers' Reserve Corps.

The legislation in question, as well as regulations relative to appointments in the Corps and other general information regarding it, is set forth in War Department General Orders, No. 32, dated July 28, 1916, and modification thereof dated March 6, 1917, copies herewith.

The War Department has no regulations, manuals, books, or other publications for distribution that will be of value to applicants for appointment in the Officers' Reserve Corps or to members of that Corps, but books and other publications desired by those preparing for examination for commissions in that Corps, or by members of the Corps for professional use, can probably be obtained by purchase from the following:

Book Department, Army Service Schools, Fort Leavenworth, Kansas.

U. S. Infantry Association, Union Trust Building, Washington, D. C.

U. S. Cavalry Association, Fort Leavenworth, Kansas.
Superintendent, Public Documents, Government Printing Office, Washington, D. C.

Application for information concerning the examination of persons who desire to enter the Corps mentioned should be addressed to the Commanding General of the Department indicated below if the examination is desired for commission in the line (infantry, cavalry, field artillery, and coast artillery). If a commission is desired in a staff corps or department (Medical, Adjutant General, Judge Advocate General's, Inspector General's, Quartermaster, Engineer, Ordnance and Signal Corps), application should be addressed to the head of the staff corps or department concerned, War Department, Washington, D. C.

H. P. McCain,

The Adjutant General.

COMMANDING GENERAL, EASTERN DEPARTMENT,
GOVERNOR'S ISLAND, NEW YORK; COM-
MANDING GENERAL, SOUTHERN DEPART-
MENT, FORT SAM HOUSTON, TEXAS; COM-
MANDING GENERAL, CENTRAL DEPARTMENT,
CHICAGO, ILLINOIS; COMMANDING GEN-
ERAL, WESTERN DEPARTMENT, SAN FRAN-
CISCO, CALIFORNIA.

The following information was received from the Commandant of the Fourth Naval District and Commandant of the Philadelphia Navy Yard.

THE NAVAL COAST DEFENSE RESERVE AND THE DEFENSE OF THE FOURTH NAVAL DISTRICT

THE Naval Coast Defense Reserve, which is a Federal organization, is designed for the naval defense of the Fourth Naval District. This district extends on the sea coast from Barnegat Bay, N. J., to Assateague Inlet, Va., and includes Delaware Bay and River.

The naval defense of this district is in the sole hands of the Commandant of the Fourth Naval District, Captain Robert L. Russell, U. S. Navy, who is, in addition, Commandant of the Philadelphia Navy Yard. The Commandant must provide his own force for the defense of this district, and this force is called the Naval Coast Defense Reserve.

The duties of this Naval Coast Defense Reserve will be largely on board mine layers, mine sweepers, submarine chasers, and patrol boats at the mouth of Delaware Bay and other parts of the district. In addition, there will be a large number of men employed on shore as signal men, lookouts, and, at supply depots, repair work and other things looking toward the upkeep of the floating force.

Tugboats, merchant vessels, yachts, and motor boats will be armed and placed on this duty in time of war. To a certain extent the vessels themselves are in existence, but at the present time the force required to man these

vessels is not in existence. It is this force, including men of every trade and activity who are physically able, whether they have had previous naval or military training or not, that it is now desired to enroll.

The men entail by enrolling no responsibility in time of peace, but are subject to call to active duty in time of war. When employed on active duty in time of war they receive the regular navy pay of the grade in which they are enrolled. In time of peace they receive \$12 per year as a retainer. If they serve three months in active duty during an enrollment, they receive, after confirmation in their grade, a retainer pay of two months' pay a year.

It is also desired to coördinate civilian work for the good of the naval service with the work of the naval authorities so that civilians interested may coöperate with and assist the Commandant of the Fourth Naval District, to the end that all desirable activities shall be carried on with a minimum of duplication and confusion. It is proposed that certain civilian committees shall be appointed for coöperation with the Commandant in the enrollment of men and in taking other measures of preparedness and in various activities in connection with the defenses of the Fourth Naval District. These committees will select one representative member, who will be appointed an Aide to

the Commandant and who will meet the Commandant and the various other Aides at frequent intervals for discussion and arrangement of matters concerning the Fourth Naval District. It is proposed that for the present these Aides shall be as follows:

An Aide to the Commandant representing the Mayor's Committee of the City of Philadelphia.

An Aide to the Commandant representing the Navy League.

An Aide to the Commandant representing the Navy Training Association of the United States.

An Aide to the Commandant representing the various Yacht Clubs of the District.

Offices for the above-named purposes and for the enrollment of the Navy Reserve for the defenses of the Fourth Naval District, in connection with a committee of leading citizens of Philadelphia to be appointed by the Hon. Thomas B. Smith, Mayor of Philadelphia, to co-operate with the Commandant in the organization above mentioned, will probably be opened very shortly in the City Hall Building, on Penn Square, Philadelphia, in rooms to be tendered by Mayor Smith.

ENROLLMENT IN THE NAVAL COAST DEFENSE RESERVE, UNITED STATES RESERVE FORCE

NAVAL COAST DEFENSE RESERVE, CLASS 4.

1. ELIGIBILITY

Citizens of the United States who are capable of performing special useful service in the Navy, or in connection with the Navy in defense of the coast, are eligible for membership in the Naval Coast Defense Reserve, United States Naval Reserve Force.

NOTE.—Owners and operators of yachts and motor power boats suitable for naval purposes in defense of the coast may be enrolled in this class and contracts made with such owners to take over their boats in time of war or national emergency upon payment of a reasonable indemnity.

Class 4. (a) Officers, provisional.

a. Must furnish satisfactory evidence as to ability, character, and citizenship.

b. Must have ability, experience, and special qualifications for important duties in naval districts.

c. Must qualify professionally for a provisional rank by examination before the commandant or an officer designated by the commandant for that purpose.

d. Must qualify physically before a medical officer of the United States Navy.

Class 4. (b) Officers, confirmation of.

After three months' active service an officer may be confirmed in his provisional rank or grade by a professional examination before a board composed of three officers not below the rank of lieutenant commander and physically before a board of two medical officers.

3. DUTIES AND REQUIREMENTS OF THE NAVAL COAST DEFENSE RESERVE.

a. Three months' active service during each enrollment. Officers and men will be assigned to active service upon application to the commandant. This service may be taken in one or more periods as the members may elect, but shall be in periods of not less than three weeks.

Penalty for noncompliance.—If a member fails to perform the three months' active service during an enrollment, he shall on reenrollment receive the retainer pay at the rate of \$12 per year until such time as he shall have completed three months' active service.

b. Enrolled members of the Naval Coast Defense Reserve shall be subject to the laws and regulations for the government of the Regular Navy only during such time as they may be on active service at their own request and when employed in authorized travel to and from such active service in the Navy.

c. Make such reports concerning movements and occupation as may be required.

Penalty for noncompliance.—Retainer pay may be forfeited.

d. An officer or man of the Naval Coast Defense Reserve shall not be an officer or enlisted man in any branch of the military service of the United States or any state thereof, but may accept employment in any other branch of the public service.

4. ENROLLMENTS, APPOINTMENTS, PAY ACCOUNTS, DISCIPLINE, ORDERS TO ACTIVE SERVICE, UNIFORM, DISCHARGES, RECORDS OF THE NAVAL COAST DEFENSE RESERVE.

ENROLLMENTS.

a. Officers designated by the commandant of a naval district shall enroll men who are eligible under the rules given. The number of men enrolled in each district will be limited by the Bureau of Navigation and the ratings conform to the district organization.

b. Every officer enrolling a man in the Naval Coast Defense Reserve shall—

1. Explain to the man that the commandant of the naval district is the man's commanding officer.

2. Explain that all requests shall be made to the commandant either by letter or in person.

3. Explain that any change in address must be promptly reported to the commandant and disbursing officer, Bureau of Supplies and Accounts, Navy Department, Washington, D. C.

4. Make out and forward account cards in triplicate to the disbursing officer.

c. Upon confirmation in rank or rating, account cards in triplicate again shall be made out and forwarded to the disbursing officer.

d. To be given a provisional rating a man must have

the technical knowledge of the corresponding rating in the Navy. To be confirmed in a provisional rating a man must in addition have a fair knowledge of naval discipline and customs. To be advanced in rating, a man must have the technical knowledge of the corresponding rating in the Navy and a good knowledge of naval customs and methods.

e. After a man is confirmed in his rating, he receives retainer pay of class 4 (d). In case he does not perform the minimum active service required in an enrollment, upon reënrolling he shall receive the pay of class 4 (c), until such time as he shall have completed three months' active service.

APPOINTMENTS.

f. An enrolled man eligible for appointment to a provisional rank or grade may be examined professionally by the commandant or by an officer designated by the commandant for that purpose and examined by a medical officer.

g. A civilian eligible for appointment to a provisional rank or grade may likewise be examined. The number of appointments will be limited by the Bureau of Navigation.

h. The commandant shall make recommendations to the Bureau of Navigation for appointment to a provisional rank or grade. Appointments are issued by the Bureau of Navigation, and upon receipt of "Acceptance and oath of office" the Bureau of Navigation will issue order to officers to report by letter to commandant of the naval district.

i. Officers must complete not less than three months' active service in a provisional rank or grade to become eligible for confirmation. The commandant is authorized to order such eligible officers as have been satisfactory in their provisional appointment to appear before a board of two medical officers for physical examination and before a board of three naval officers, not below the rank of lieutenant commander, for professional examination for confirmation of provisional appointment. The Boards shall conduct examinations in accordance with the department's precepts of October 16, 1916, and subsequent modifications which have been furnished the commandants in blank. Upon the receipt of records of examination in the department, the commandant and candidates will be notified of the department's action thereon. The commandant is authorized to appoint supervisory boards in special cases when it is deemed impracticable for the candidate to appear before the regular boards above named.

j. For appointment to a provisional rank, an officer must have the qualifications along the line of duty to be performed that would be required of a naval officer.

k. An officer to be confirmed must have, in addition to the knowledge required for a provisional appointment, a general knowledge of the customs and discipline of the naval service.

PAY ACCOUNTS.

1. Account cards are made out in triplicate by the commandant of naval districts as follows:

1. Upon enrolling or reënrolling a man in the Naval Coast Defense Reserve or upon receipt of record of enrollment when enrollment is not made in the reserve office.

2. Upon appointment of an officer under his command to the Naval Coast Defense Reserve.

m. Account cards are sent to the disbursing officer, Bureau of Supplies and Accounts, Navy Department, Washington, D. C. Account cards may be obtained from the supply officer, navy yard, Washington, D. C., after December 1, 1916, and will be issued without request as soon as printed.

n. Account cards will be made out in accordance with instructions on the back thereof.

o. Any change in rank or rating or any changes that would in any way stop or affect pay shall be reported at once to the disbursing officer.

DISCIPLINE.

p. Members of the Naval Coast Defense Reserve when on active service shall be subject to the discipline of the Navy.

RETIREMENTS.

q. Enrolled members who have completed 20 years' service in the Naval Reserve Force and who shall have performed the minimum amount of active service required in their class for maintaining efficiency for each term enrolled shall upon their application be retired with the rank or rating held by them at the time and shall receive in lieu of any pay a cash gratuity equal to the total amount of their retainer pay during the last term of their enrollment.

ACTIVE SERVICE ASSIGNMENTS.

r. To order a man to active service upon his own request the following procedure shall be followed:

1. The commandant of a naval district issues orders, transportation, and subsistence and forwards enrollments and health records with copy of orders to the commanding officer of the ship or station to which the man is ordered.

2. The commanding officer enters on his enrollment record the date of reporting, the date of detachment, and proficiency marks. The record is handled in the same manner as that of a regular enlisted man.

3. The commanding officer shall on completion of the active service training period as indicated by orders, or as soon thereafter as practical, detach the man and procure for him transportation and subsistence to his home (or other place, provided that this can be done at no greater expense) and forward the enrollment record and health record to the commandant of the naval district.

4. The pay officer of ship or station will pay members of the Naval Coast Defense Reserve on active duty as are paid officers and men of the Navy. (Active service counts from the date of reporting to date of detachment.) Mileage of officers ordered to active service shall be paid in the same manner as to officers of the Navy.

(Continued on page opposite 197)



SOCIETY OF AUTOMOBILE ENGINEERS

PENNSYLVANIA SECTION



JOHN W. WATSON, Chairman

A. K. BRUMBAUGH, Secretary, Autocar Co., Ardmore, Pa.

Especial attention is called to the meeting of the Illuminating Engineering Society to be held on April 20. The paper of the evening will be "AUTOMOBILE HEADLAMPS," and the members of the Society of Automobile Engineers are invited to attend this meeting.

The Automotive of War

By JOSEPH A. STEINMETZ

PRESIDENT OF AERO CLUB OF PENNSYLVANIA, MEMBER OF AERONAUTICAL MAP AND LANDING PLACES
COMMITTEE OF THE AERO CLUB OF AMERICA

MEMBER OF THE PUBLIC SAFETY COMMITTEE ON AVIATION

MEMBERS of the Society of Automobile Engineers: I first conceived the thought that we would speak of the automotive of war as related largely to transport.

Let us consider "automotive" as its etymology and significance imply—the motive force—the impelling force and the great dynamic force of war other than man power, yet so intimately associated with muscle and mental energy and soulful impulse that it is one and the same. It is, as the Greeks would say, "the God in the machine." Without it, all these great creations would be impotent. Without the heroism of the man at the periscope, or the hand at the throttle, or the directing genius at the base, all this great automotive force would be so much pig iron or junk—a dead body without a soul.

I won't continue in the vein of technique. I could have written a paper that would have taken probably a month to write and a minute to throw away when you saw it. The technique of all these things is written by 30,000 of our American engineers in a hundred splendid volumes on your shelves and on your tables and in the library of this great Engineers' Club for your reference.

So I will take up the narrative as the suggestions come to me from the pictures as they are thrown on the screen. There are some things that I have been asked not to speak about.

It will interest you men to know that a great, tremendous movement is pounding forward, toward a definite and final purpose in this country, and that is for positive national defense. The great undercurrent of national direction is now working. Some of you men have felt it in the last two weeks. Some of you will feel it in the near future. It is the directing mind of groups of men coördinating with the engineers—the human element of our country—weaving them into a positive and strong fabric from what has previously been very loosely hung together—a miscellaneous and inefficient grouping.

* Presented before the Society of Automobile Engineers, February 21, 1917, at Engineers' Club.

I think that we are all zealous of doing something for our country, but that the pathos of it has been we are not a country that cares about national preparedness or about military preparation, although of late they have been pouring money through the national budget in millions of appropriations, which will soon, in total, exceed a billion dollars.

It reminds me of a story of Admiral Fisk last week, when he said a friend of his was a fast runner—one of the fastest men he ever saw run. To be sure, he was equipped with schedules, but the dickens of it was that when he got to the station the train was always gone. His friends chided him about it, and said he wasn't quick enough. He said, "I have come to the conclusion that that was not my trouble; I went fast enough when I got started, but I did not start soon enough." The parable of that story is apparent. If we do not start to prepare soon enough, all the money in the world is not going to build, equip, ordnance, armor, and man a battleship. It takes five years to get a boat from the rolling mill and the structural mill into the shipyard, and set together, overboard, machinery in, turrets in place, armor on, guns made and mounted, and ammunition supplies in. Five years is a long wait.

We have a strong navy, as it goes, ship for ship. Our great boast has been that, ship for ship, it was as good as any navy in the world. That may be granted, but it is far down in the list of efficient ships at present on the water, ready for action.

The budget that we have laid down, while it represents an expenditure of many millions of dollars in the next six years, is really not in the navy at all. It is a promissory note to do something if we can. You men who are familiar with furnishing materials and getting supplies together know that conceiving a model of an automobile, perchance, or an engine, is one thing, and getting production in thousands of units and getting your material together is quite another. The intention is good, but it is the net result that counts, and in the net result we are not at present ready. We are striving to get ready, and

if the great catastrophe of the world should enmesh us, will do the best we can.

I was looking at the *Outlook* to-night, and one of the thoughts that I want to get to you is, What should America do in war—if it follows that we must get into this thing? We are loath to get into it. I think we have been very patient for a year or two, but some night or some day it is almost certain that something will happen—within or without, it doesn't matter much where—and the nation will be so bothered, or so chagrined or unhappy that the next step will follow and we will be in war. The choosing will not then be ours. As we are Americans, we must be Americans, and if fate decrees that it is a nation to the far east or west of us, then the hand of fate must show the direction in which to go. I think we all know that direction; it is to follow the flag.

We will not go into the ancient history of the art of aeronautics, of ballooning, or any of those features. They are all quite old. We will begin with the greatest airship of the world—the German Zeppelin. The earlier French and English models of dirigible are known as the non-rigid type. They are trussed back and forth by seams of canvas or stiffeners, which will take care of any small tension changes, but under stress have a tendency to buckle. The Zeppelin is much larger and it is known as the rigid type.

It was my good luck to be at Lake Constance and witness the flight of Zeppelin's original little aircraft, somewhat less than 300 feet long. The Count got it up and flew very nicely indeed. It may refresh you engineers to know that he had great trouble when he came down and brought it into shore; the wind tossed it about and damaged it, and he did not know what to do. There was a young American there who suggested to the Count that he could fix it if he could put it on pontoons, and he conceived the idea of anchoring the hangar in the middle of the lake, so that it was always going into a definite wind current, without side winds, and in that way he worked out the floating hangars which were very popular for some time.

Perhaps it might be interesting, for the benefit of the engineers present, to discuss the Zeppelin a little more in detail. The Zeppelin is a tremendous structure, seven hundred feet long in the latest models, and seventy feet in diameter, having a capacity of more than a million cubic feet of hydrogen. It can cover a considerable distance; it has a zone of flight of five hundred to over a thousand miles. This type of dirigible carries a crew of some twenty to thirty men and fifteen to fifty tons of dead load. It is propelled by four great propellers, two on each side, driven from two power plants, having a combined horsepower in excess of 1000. There are sixteen to twenty compartments, each of which contains a balloon, separately filled with hydrogen, the theory being that first you have a string of balloons like a string of pearls, all rigid, in line, and, in event of one being shot away, you have still ample sustaining power to keep the craft afloat in the air. The outer body is covered with oiled

or shellacked linen, so that it gives a good windage and slips through the air with the least possible resistance, with its long stream line and cigar-shaped body. At present they are mounting high-power guns on the Zeppelins. In a gale beating down eighty or ninety miles an hour, over the North Sea, with the rain coming down or the temperature at zero, and this dirigible pitching and rolling and suddenly getting out of the way of an aircraft gun from above you—believe me, that is some deck!

At the time of the Zeppelin raid over London, the Zeppelins left their base on the Belgian coast on the North Sea at nine o'clock at night. You know in London, in the summer days, it is almost light enough to read at half-past nine o'clock in the evening. And then, at eleven o'clock, they came over the metropolitan area. We now know why the greatest damage was at the theatre hour. After dumping over their charge of bombs they turned, and at midnight were over the North Sea and by sunrise were almost home at their base.

I do not think that we have fully realized the significance of this tremendous Zeppelin. We have started to build a Zeppelin in this country. We won't have much trouble in constructing it; the difficulty will be in manning it, for it requires a skilled group of men to understand its navigation, and it may be some years before we reach any efficiency in the control of these great dirigibles.

One of the methods of attack is simply flying at the Zeppelin and letting slip a small bomb on a piano wire; for Zeppelins the aeroplane patrols with bombs at the end of wires 2000 feet long. They locate the dirigible from the noise below in the fog, or a searchlight beam on the end of a wire and set off a charge of high explosives. It is now supposed that the Zeppelin menace has been met, and we do not believe that any more important Zeppelin attacks will be made on England.

Among the buildings which a Zeppelin would be apt to attack with its bombs in a raid on England would be the immense factories, and this led some one to ask the question, "Why not build dummy factories? Why not take corrugated iron and construct it in the form of a factory, and then make a noise with tin cans or with some other means, and light up the interior with waste?" They build dozens of these just outside of London, and a Zeppelin would come in and when they got near they would make a noise and light fires, so that the Zeppelin crew would say, "Oh, there she is! There is a big munition plant." They would then drop over their bombs. They come with these bombs for a distance of two or three hundred miles, so when they kick them over they have to go back for more, and when they get back they are congratulated by their friends for having blown up some factories.

Here is probably the most infernal invention in the world. It is called the "thermit" bomb. You who are metallurgists know that if you associate powdered aluminum and oxide of iron and ignite the mass you get a

melting-point that will give you practically fluid steel at a white heat of some 3000 degrees. They fill this bomb with thermit. This bomb then descends, and in the bottom is a detonator with a high explosive charge. This weighs about half a ton, and when it strikes a building it goes through the roof. The detonator has time to act and the booster charge blows it up. A mess of the molten steel is splattered over an area of a block or two.

Out of the 16,000 inventions offered to England in the first year, the War Office said that there were only two that they could use. This seems hardly credible. First of all, I think that they did not look at them carefully, because I cannot imagine so great a number yielding only two good things. If such a thing occurred in the United States I would think it about time to shut up shop. It is interesting to note that very conservative estimates indicate that over 80 per cent. of devices for warfare, either offense or defense, are entirely civilian inventions, so you see the average is in favor of you men. Many of the important things have been worked out by the clerks at the desks, many by men at the benches or at the machines in the factories, who had no conception of technique.

Let us touch the *aéroplane*, briefly; it again is an automotive of war. Professor Langley, you know, was one of the first to conceive of an *aéroplane*. It was my good luck to be one of "his boys" at the time. I worked out for him a little problem in seamless steel. He was very much gratified and he got them on his *aéroplane*; but unfortunately he had too much pig iron weight per horsepower; his engine was too heavy; he had about ten times as much weight as he should have had or as we have to-day. We are at present getting our engine down to three to five pounds of weight per horsepower, and we hope to get it down to a pound of weight per horsepower.

Professor Langley tried to make a flight over the Potomac and went down into the bed of the stream. People thought it was foolish to attempt to build a machine to fly. The press ridiculed Langley and told him he was crazy, and he was caricatured. There were a few of the sturdies who said, "That's all right. We will get it yet! It was a perfectly proper attempt."

Now let us see how proper an attempt it was. Just before the beginning of this great war, in the summer of 1914, it was my good luck to be at Hammondsport, N. Y., and I saw there the original Langley invention. They shined, painted, and fixed it, took out the old Langley engine, which was a wreck, and put in its place a Curtiss *aéroplane* engine. They coupled it up and got everything ready and then cast loose and got out on the lake. The pilot pulled over the lifting levers, and, to our tremendous joy, that great structure flew like a beautiful swallow—all without touching or altering his wing planes or in any way modifying the theory, except giving him a tremendous horsepower with a low weight, and he flew! And, gentlemen, you want to pay great tribute to

Professor Langley for having really solved the principle of flight, although he himself did not fly.

At the time this picture was taken Hon. William H. Taft was Secretary of War, and I was present to witness this flight, and it was a great day. Orville Wright and Lieutenant Selfridge were flying in this Wright biplane and had been in the air for about an hour. Something got in the way, and Wright attempted a rapid change in the direction of flight, in order to avoid a smash, when down came the plane and Selfridge was killed and Wright's hip was broken. It was the first attempt of flight in the army. It was successful. I think they bought one, and for some years after slipped away to nothingness, when all the powers of the world took it up with tremendous acclaim. As you may recall, when the present war broke out the great powers had several thousand aviators in the air in twenty-four hours.

The desire, at the beginning of the war, was to fly at great heights. This was found not to be good practice, and it was also found that if a plane went very high the photographs were not very good. They are making hits now at four to five miles with six-inch calibre guns. At first a hit at a mile was considered a wonderful feat.

A picture was shown illustrating the invisible airplane wing. They are working it out on fabrics now in the form of cellulose. It is not inflammable, is practically as clear as glass, and gives us this wonderful result, as you see up here—the dragon-fly effect of the long, slim body and a reduction of the visible area of at least 60 per cent. It is very likely that war planes of the future will be practically invisible. The great wing plane may now be made transparent and invisible from the ground. Tests on this fabric show it to be stronger than the oiled linen or silk, that it is perfectly practicable and not inflammable. It is a most important discovery and one that is bound to have an effect on the strategy of war in the air.

And here we have the caterpillar tractor, made in Peoria and Stockton and other places in the United States. It is an automotive of peace. I have seen these tractors in Alberta pulling a gang of plows—twenty plows abreast, at intervals of two feet—tremendous horsepower—and the English conceived the idea of "Why couldn't we mount this as a turret and move it forward along the ground?"

And here we have the great "tank," about which we hear so much, and it is really a caterpillar tractor. It is gear-driven. It is so arranged with gears and clutches that this whole belt is ground gripping. Here (indicating) is the side turret; on the other side there is likewise a turret, and one forward, each having mounted machine guns, and here at the top is the observer's turret, with slits in it. One of these "tanks" carries five or six men and moves forward slowly. This whole machine, as you see it here, is about thirty-four feet from end to end. It can negotiate an open crater nearly twenty feet across. In crossing a ditch it wobbles out until it gets its nose on the other edge. If it comes to brick build-

ings or other small structures that it doesn't like it rubs its nose against and pushes them down and then goes over the wreck. It is a very formidable-looking thing and a very interesting device. When that is sprung at a critical moment it has a startling effect. Here (indicating) is the "tank" itself in action, and here is Hot-black, a young British officer. This young captain jumped out of the "tank" and went forward out in the open and led his "tank" through the entire battle, as you see, for a distance of nearly a mile. He was not even struck when everything else was riddled. Such a foolhardy thing could not happen once in a million times. It is just one of the accidents of war, in which the fellow went through Hades and never was singed. The "tank" is a typical expression of the "automotive of war."

We won't touch on the analysis of this or the structure, only to show you men the immense complexity of it, and the potential forces in each inch. There is not an inch of space in the submarine that is open for any idle purpose. It is all busy and useful. There is both the large and the small model. It is to attack these periscopes that these high-speed automotive boats are being built.

Here we have the automotive of war again, showing how in a few weeks they converted the railroad trains of North France and Belgium into armored batteries. A plan of that sort should be developed here. We should do it for various types of locomotives and freight cars, and should have it as part of our annual maneuvers. There should be drills in the summer and the men should be paid for it and be given prizes for converting locomotives with armor-protecting forms and devices.

In the Polish campaign they spoke of the Kaiser being several hundred miles away from a certain center, and then he would appear suddenly several hundred miles away from somewhere else, and that same day they had the Crown Prince in thirteen places. When we heard of this we thought it was ridiculous, but it was in part true. This shows the automotive of war on the deck of a sled, and they went around over the ice plains of Poland in this way. That is the *aëro-sled*, and it has become quite a fad. We have built some in our American factories, and there is no reason why you could not build a stream

line air-sled; there is no reason why you could not go miles a minute across the ice.

As to the wheels of the automotive, you will note that abroad they are using wire wheels. They found that the American wooden spoke wheel was not a success in war. One of the objections was that the wooden spoke is an inch or more in diameter. The larger it is the more serious it is, as a target. If you have 20 per cent. of your wheel area consist of visible spokes, you have one chance in five of being hit. The steel wire spoke is rarely hit, and, if hit, spins the bullet, while a wooden wheel will be shot all to pieces. They have therefore gone practically to the steel spokes and the steel disk wheels.

We ought to have 5000 or 10,000 automotive ambulance bodies ready, and we ought to have the body-forming dies and materials ready. The Government ought to keep in stock the material—ought to pay the interest charges on the steel; ought to give tentative orders, so that in an hour they could fit up the standard chassis, such as the Fords. And, by the way, those little Fords were the best of all, because they were not heavy.

Here is another type, in which you will see the action of the turret in the rear, in case of retreat.

Here is one with a machine gun on the top, and below a one-pounder for long-range fire.

Here are the signalers, rushing from place to place with wires and battery—the whole signal corps.

Our great General George Washington said, "This country should be defended by its men." Jefferson said that "every man should have a military flintlock hung up over his hearthstone, ready for the nation's call, and in every cupboard should be thirteen bullets of lead, one-half inch in diameter, and every man should stand to defend the realm." That was his conception of service; and we should have universal service in this country—not necessarily exclusively military service, but service. There is not any reason why a splendid tool-maker in this group, or otherwise engaged in the great art of production, should not be in the service and for a term of two years, and the work that he does at his bench should be counted to the credit of his national service.

Lincoln said, "Had I but 50,000 trained soldiers at the outbreak of the Civil War, I should have stopped the whole tragedy in thirty days."

ELEPHANT BRAND

ELEPHANT BRAND  DELTA REG. U. S. PAT. OFF.	THE PHOSPHOR BRONZE SMELTING CO. 2200 WASHINGTON AVENUE, PHILADELPHIA, PA. ELEPHANT BRAND "Phosphor-Bronze" INGOTS, CASTINGS, WIRE, SHEETS, RODS, Etc. —DELTA METAL— IN BARS FOR FORGING AND FINISHED RODS ORIGINAL AND SOLE MAKERS IN THE U. S.
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PHOSPHOR BRONZE



TECHNOLOGY CLUB OF PHILADELPHIA



D. K. BULLENS, Chairman

C. J. WALTON, Secretary, 1421 Arch Street

Coming Meetings: April 4. Election of Officers. "TELEPHONE ENGINEERING," by P. E. TILLSON, of the Bell Telephone Company. May 2. "RADIO WORK," by E. D. FORBES, of the Philadelphia Navy Yard.

THE Institute, the alumni, and the undergraduate body have all taken steps toward preparedness for national emergencies. Immediately after the breaking of diplomatic relations with Germany, President Maclaurin offered to the Government the entire laboratory facilities of the Institute, and the services of its staff of instruction. At the same time he called a mass meeting of undergraduates and impressed upon them the need of deliberate, intelligent action on their part in order that the service they might render would be that for which they would be best fitted and in which they could be most effective.

Following this advice, an undergraduate committee has been appointed and an investigation is being made as to the details of the various lines in which Technology students can be most useful. The report of this committee will be of valuable assistance in directing the efforts of the student body.

The alumni association has undertaken the collection of data which will make possible the effective mobilization of Technology's resources. At the request of the Committee of National Defense, and with its coöperation, a bulletin has been issued to all former students of the Institute requesting an immediate return of information in reference to ability and experience, both in direct military affairs and in lines of industry necessary to the proper maintenance of warfare. The latter data are covered in a self-indexing list of many activities in which Technology men are interested and which would have a bearing on preparedness. There are twenty-five main headings, each with many subdivisions and each bearing a definite code. For instance, the following is an example of one of these headings:

13. Small tools:

- (a) Gauges.
- (b) Jigs.
- (c) Dies, stamping.
- (d) Dies, drop forging.
- (e) Taps and dies.
- (f) Drills.
- (g) Reamers.

The results obtained from the data sheets will be tabulated and presented to the Committee of National Defense. It is understood that this work on the part of Technology's alumni will be taken as a basis for securing similar data from other technical institutions.

Technology is also about to take steps toward the training of its students for permanent preparedness by the establishment of a reserve officers' training unit at the Institute. The government regulations require that five hours per week for four years be devoted to military training. Such an increase in the load of a student at Technology is obviously out of the question. The surroundings of the Institute are also such that proper training in purely military lines, such as extended order work, etc., is impossible. Major Cole, head of the Department of Military Science, has prepared the outline of a course which would be adapted to the conditions at the Institute and which will prepare Technology men along lines in which they will be of most service. It is the idea not to train officers for the combat arms of the service, but for the engineer, signal, and ordnance corps. The proposed course will cover the essentials of military drill and discipline, probably being the equivalent to the present work in the freshman year. The remainder of the course will consist of the application to military purposes of certain portions of the regular technical courses. This will consist in segregating parts of the various courses that have particular bearing on military subjects. For instance, certain subjects given in the mechanical engineering course can be applied directly to ordnance and munition work, and these subjects will be presented so that their military value will be emphasized. The military value in some directions of the present courses at the Institute is illustrated by the fact that fifty per cent. of the officers entering the regular army engineer corps from civil life last year were recent Technology graduates.

The course as outlined by Major Cole has been presented to the War Department, and advice has been received that it is in accordance with the desires of the Department, and that a commission of officers, including Major Cole, has been appointed to prepare definitely the courses for the Institute which will meet the requirements for a reserve officers' training unit.



AMERICAN SOCIETY OF MECHANICAL ENGINEERS .: PHILADELPHIA SECTION

EMMETT B. CARTER, Chairman

W. R. JONES, Secretary, Eng. Dept., Univ. of Penn.



The Design, Construction and Equipment of A Modern Military Aëroplane

By J. C. HUNSAKER

THE Franklin Institute and Mechanical Engineers held a most excellent joint meeting in the former's auditorium on the evening of Thursday, March 15. The speaker was Dr. J. C. Hunsaker, U. S. Naval Constructor, and the subject was the "Design, Construction, and Equipment of a Modern Military Aëroplane."

Mr. George R. Henderson, in introducing the speaker, spoke of the unsuccessful but well-known experiments of Professor Langley at the Smithsonian Institution. He said that had Professor Langley lived he could have appreciated very keenly the development of the art of which he saw only the failure side.

For obvious reasons the speaker refrained from any reference to the present status of the United States air force or to its proposed plans for the future. It is difficult and practically impossible to design a "heavier-than-air" machine that will answer efficiently for more than one purpose. It may be designed for lightness, speed, and ease of control. In this case it is not good for weight-carrying or for prolonged ascents. On the other hand, it may be designed to carry bombs, in which case it is likely to become heavy, have a wide spread of wings, be cumbersome and be difficult to maneuver.

The present great war of the Powers has brought out a most wonderful development of the machine for military purposes. Perhaps, after the war, the development of the machine might be in the direction of mail carrying, pleasure, or touring.

It seemed curious that when one of the combatants developed a certain type of machine the other immediately followed with a similar type, with the hope of improving upon the design. Perhaps the most striking of these types has been the small French biplane, humorously called "Tabloid." It is driven by a rotary Gnome engine, in which the cylinders revolve, but the crank-shaft is stationary and rigidly fixed to the frame of the machine. This machine is capable of almost unbelievable speeds. It is positively known that it can easily travel at 130

miles per hour, and that the enormous speed of 140 to 150 miles has been reached at times.

The Powers have tried out the various types of machine guns for use on aëroplanes. They have been mounted in various positions—usually there is a pilot and a machine-gun operator on the machine—but one kind of machine has developed in which one man operated the machine and also pointed and fired the gun. It is thought that the gun is rigid in one direction and that the aiming was done partly by pointing the machine.

The value of the modern aëroplane as a reconnaissance machine is, of course, undisputed. It has been cited that the French, who, by the way, have practically maintained the supremacy of the air during the war, photograph the trenches of the enemy every morning at a certain time so that the commanders may learn what progress the enemy has made during the night.

The development of the machine has been much more rapid on land than on the sea—perhaps chiefly because the present war has been a land war rather than a naval one. Different problems are met with in the development of a sea machine. In general there are two methods of ascent—from the water and from a catapult in which the motive power is compressed air.

These machines must not operate too far from the "mother" ship, as it is an easy matter for them to become lost. They are sometimes equipped with radio. Their observations must be made rapidly and they cannot approach an enemy ship too close on account of the high efficiency maintained by modern anti-aircraft guns. The dropping of bombs from a naval plane is, therefore, not feasible at the present time.

Great interest was shown in an old moving-picture film of the Wright Brothers at Fort Myer a great many years ago. A very wonderful moving picture in which many types of air machines appeared was also shown. This film was taken in France only recently. The speaker was asked many questions pertaining to the development and use of military planes.

AVERAGE RESULTS OF TESTS OF PORTLAND CEMENT

MADE DURING 1916

DEPARTMENT OF PUBLIC WORKS—BUREAU OF SURVEYS TESTING LABORATORY

BRAND	NUMBER OF SAMPLES TESTED	FINENESS, IN PER CENT			SPECIFIC GRAVITY	SETTING		PERCENT OF WATER OF NEAT	TENSILE STRENGTH IN LBS. PER SQ. IN.		
		NO. 50	NO. 100	NO. 200		TIME IN MIN. INITIAL	HARD		24H	7D	28D
Allentown	52	0.2	4.4	19.3	3.164	193	377	72.8-75.2	338	635	692
Alpha	15	0.1	4.0	20.6	3.151	172	370	74.5-78.5	420	630	635
Atlas	22	0.1	4.1	20.3	3.151	172	371	73.7-76.5	486	621	628
Bath	74	0.0	4.6	19.2	3.124	217	395	74.0-75.9	399	655	675
Dexter	64	0.2	3.1	17.0	3.140	178	358	74.1-77.3	391	626	652
Dragon	148	0.1	3.2	17.7	3.145	177	359	74.3-76.7	460	636	627
Edison	33	0.3	3.4	16.3	3.148	185	374	76.3-78.3	309	535	583
French	1	0.0	2.4	18.2	3.202	234	394	69.0-70.0	290	553	662
Giant	9	0.1	4.2	19.5	3.171	231	392	70.1-73.0	353	671	693
Lehigh	69	0.1	3.7	20.0	3.175	179	369	72.4-74.6	345	658	709
Nazareth	169	0.1	1.7	13.6	3.150	173	357	72.9-75.2	421	655	659
Penn-Allen	49	0.1	4.7	20.4	3.150	186	364	73.3-74.9	408	625	642
Pennsylvania	177	0.0	2.4	16.5	3.155	175	366	72.3-74.4	367	605	638
Phoenix	94	0.0	2.2	16.4	3.136	176	355	72.6-74.7	424	645	659
Saylor's	124	0.2	2.1	16.5	3.181	235	393	72.6-74.2	244	611	699
Tidewater	12	0.0	3.9	19.2	3.179	171	368	72.9-75.9	313	622	717
Vulcanite	30	0.0	3.8	19.3	3.165	229	385	72.7-74.8	267	662	713
Whitehall	119	0.1	3.4	18.5	3.152	172	343	73.5-75.7	399	639	653

CHESTER E. ALBRIGHT
CHIEF ENGINEERGUY WISE
ENGINEER OF TESTS



ILLUMINATING ENGINEERING SOCIETY PHILADELPHIA SECTION

ROBERT B. ELY, Chairman

T. ELMER MOON, Secretary



Next Meeting, Friday, April 20, 1917, 8 P.M., at the ENGINEERS' CLUB. Subject: "AUTOMOBILE HEAD-LAMPS," by Dr. H. P. GAGE, of the Corning Glass Company, Corning, N. Y. This will be preceded by one of the popular talks on the "Fundamentals of Illuminating Engineering." There will also be an exhibition of all types of automobile head-lamps.

The Illuminating Engineering Society enjoys having Affiliated and Club Members attend its meetings. The paper on "AUTOMOBILE HEAD-LAMPS," to be presented on April 20, should especially interest the Society of Automobile Engineers.

THE regular monthly meeting of the Philadelphia Section of the Illuminating Engineering Society was held at the Engineers' Club, 1317 Spruce Street, on March 16, 1917.

Dinner before the meeting was attended by Mr. G. H. Stickney, general secretary of the society, who gave us a short talk on the significance of St. Patrick's Day in Illuminating Engineering.

Preceding the reading of the paper, Dr. G. A. Hoadley

presented a short illustrated lecture on the method of calculating illumination by means of the equation:

$$\text{Illumination} = \text{candle power of source} \div \text{square of distance}$$
which aroused considerable discussion.

The speaker of the evening was Mr. G. Harry Swanfeld, of the G. H. Swanfeld Engineering Company, of Philadelphia, who presented a communication on "Indirect Lighting Design," amply illustrated by lantern slides of notable installations.

Indirect Lighting Design

(ABSTRACT)

By G. HARRY SWANFELD

THE present high efficiency of lamps makes economically possible a system of lighting of comparatively low utilization factor wherein the source of light is entirely obscured and illumination received from the ceiling as a secondary source. This is equivalent to an extended source relatively close to the reference plane. The resultant illumination is of a high degree of diffusion, eliminating sharply-defined shadows and reducing glare from glossy surfaces. There are shadows produced by the predominant downward flux, but they are greatly softened. Even with "indirect lighting" highly-glazed reading pages may cause discomfort.

When it comes to the calculation of installations, while the characteristics of the light source play an important rôle, knowledge of other factors is necessary.

In fact, what we are most concerned with are the ceilings and walls, since these are the effective light sources. They completely alter conditions. Heretofore the light sources were very small, and, relative to their size, comparatively distant from the surface to be illuminated, ordinarily called the plane of reference. Hence the inverse square law could be applied and reasonably exact computations made by its application. With indirect lighting, conditions are reversed. The effective light source, the ceiling and walls, is large in area and, relative to its size, in close proximity to the plane of reference. Hence the inverse square law cannot be applied. Although the fundamental method of making lighting calculations is

to calculate the illumination point by point, employing the inverse square law, another more convenient method has come into vogue, known as the "flux-of-light" method. The application of this method is dependent upon the full knowledge of the characteristics of the lighting equipment and its application to different types of interiors. It is a ready means of disposing of the problem of lighting calculations for indirect installations.

The application of the flux-of-light method of calculation assumes an intimate knowledge of the percentage of total light flux available on the plane of reference. This percentage, called the efficiency of utilization, has been worked out under numerous fixed conditions, the results of which are shown in Table I.

TABLE I

Dimension Factor	Efficiency of Utilization, per cent.*		
	Light walls (Coefficient of reflection 0.65)	Medium walls (Coefficient of reflection 0.40)	Dark walls (Coefficient of reflection 0.05)
1	.27	.17	.14
2	.34	.26	.22
3	.38	.31	.26
4	.40	.34	.30

$$\text{Dimension Factor} = \frac{\text{Minimum Dimension of Room}}{\text{Ceiling Height}}$$

*These values of utilization efficiency apply only for installations in interiors having white or light cream ceilings (coefficient of reflection about 0.65).

NOTE.—This table is taken from tests conducted by National X-Ray Reflector Co., Engineering Dept.

ENGINEERS' CLUB OF PHILADELPHIA

From Table I it will be noted that the efficiency of utilization varies with the proportions of the room. Thus in a narrow high room the efficiency is lower than in a broad low room. The chief reason for this is the greater loss of light in double reflection from the walls.

The color of walls also has an effect on the utilization efficiency. If the walls are dark, but little light intercepted by them will be available on the plane of reference, but if they are light, a considerable increase in efficiency results.

Having knowledge of the utilization efficiency that may be expected under various conditions of everyday lighting practice, the next step is to determine the quantity of luminous flux it is necessary to deliver to the plane of reference in order that the lighting may be satisfactory. This quantity depends on a variety of factors: (1) Dark-

colored objects require more illumination than light ones; (2) work requiring close discrimination of fine detail requires higher illumination intensity than, for instance, ordinary reading; (3) for long periods of application high intensities are helpful in reducing eye-fatigue; (4) for rapid seeing high intensities are adequate. From long experience we have come into possession of quite definite knowledge of the illumination intensities required for a variety of purposes. In Table II is tabulated the intensity in foot-candles commonly recognized as satisfactory lighting in a number of types of interiors in which indirect lighting proves ideal. Since the foot-candle is the flux density in lumens per square foot, multiplying the area to be illuminated by the required foot-candles intensity gives the effective lumens which must be delivered to it.

Once the amount of primary light flux required is known, the number and size of lamps may be determined from Table III.

TABLE II

DATA TAKEN FROM ENGINEERING DATA BOOK OF THE NATIONAL X-RAY REFLECTOR, CHICAGO

Required Illumination	Foot-candles	Required Illumination	Foot-candles
<i>Churches:</i>		<i>Factories:</i>	
Auditorium	2.5 - 3	Textile mills	6 - 8
Entrance	2.5	Sewing rooms	6 - 8
Sunday-school room	1 - 2		
<i>Hospitals:</i>		<i>Residences:</i>	
Corridor	¾	Bed-room	0.5 - 1
Operating rooms ...	6 - 10	Dining-room	1 - 2
Ward	0.5 - 1.5	Hall	0.25 - 0.5
		Living-room	1 - 2.5
<i>Hotels and Clubs:</i>		<i>Schools:</i>	
Ball-room	3 - 3.5	Class-room	2 - 3
Barber shop	3.5 - 4.5	Class-room (business college) ...	3 - 5
Bath-room	1.5 - 3	Laboratory	3 - 5
Bed-room	1 - 1.5	Library and reading-room	2.5 - 4
Billiard-room	3.5 - 4.5	Museum	2 - 3
Buffet	4 - 4.5		
Card-room	3 - 3.5	<i>Stores and Sales Rooms:</i>	
Corridor	0.5 - 0.75	Dark display	4 - 6
Dining-room	2 - 3	Fitting room	4 - 6
Kitchen	2.5 - 3	Light display	3 - 5
Lobby	3 - 4		
Lodge-room	3 - 3.5	<i>Theatres:</i>	
Lounging or rest-room	1.5 - 2	Auditoriums	2.5 - 3.5
Parlor	1.5 - 2.5	Auditorium (moving picture):	
Restaurant	3.5 - 4.5	Dim	0.25 - 0.5
Writing-room	3 - 3.5	Bright	2 - 2.5
		Lobby	4 - 6
<i>Offices:</i>		<i>Miscellaneous:</i>	
Accounting	3.5 - 5	Armory	2 - 3
Banking	3.5 - 5	Art gallery	3 - 4
Corridors (first floor	2 - 3	Court-room	3 - 4
Corridors (above first floor)	0.5 - 1.5	Gymnasium	3 - 4
Drafting	7.5 - 10	Skating rink	2 - 3
General	3 - 4	Station waiting-room	3 - 4
Private	2.5 - 4	Studio	2 - 3.5
Stenographic	4 - 5	Telegraph office	
Stock	2.5	operating-room ..	3 - 4
Vaults and filing ..	2 - 3	Telephone Exchange	3 - 4

TABLE III

DATA TAKEN FROM HANDBOOK ON ILLUMINATION OF THE EDISON LAMP WORKS OF THE GENERAL ELECTRIC COMPANY

<i>Vacuum Tungsten Lamps</i>	
Lamp size watts	Total lumens
10	75
15	128
20	178
25	234
40	381
60	588
100	1032
<i>Gas-filled Tungsten Lamps</i>	
Lamp size watts	Total lumens
100	1257
200	2795
300	4600
400	6130
500	8060
750	12,740
1000	17,960

The choice of the number of units is dependent upon the dimensions of the interior and the character of work carried on. A uniform illumination may be desirable, but in many instances a degree of non-uniformity is permissible.

With indirect lighting the spacing between outlets should not exceed 1.5 times the ceiling height if the illumination on a horizontal plane 30 inches above the floor ("desk level") shall be uniform. Where uniformity of intensity is not essential, greater spacings are permissible, but in extreme cases should not exceed 2.5 times the ceiling height.

As to the length of suspension of the indirect fixture, in the writer's opinion this should be chosen so that the illuminated field on the ceiling from adjoining units overlaps, since this gives the most pleasing ceiling effect. With a properly designed reflector this may be accomplished with ordinary suspensions and without great loss in efficiency of reflection from the ceiling.

PENNSYLVANIA PORTLAND CEMENT

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POLO GROUNDS GRAND STAND, NEW YORK CITY
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NEW YORK AND SUSQUEHANNA RAILROAD BRIDGE, PENNA.
TUNNEL UNDER HARLEM RIVER, N. Y. C. "HOFF'S SYSTEM"

CONCRETE FOR PERMANENCE

ONE SOURCE—ONE MILL—ONE STANDARD

(Continued from page 189)

UNIFORM.

s. Men in the Naval Coast Defense Reserve shall keep on hand such part of the uniform clothing outfit as prescribed below. When first called into active service, the commanding officer of the vessel to which attached will issue an outfit as given in the following table, which must be kept on hand thereafter while a member of the Naval Coast Defense Reserve and be presented for inspection when required. In addition, the commanding officer shall issue such articles of clothing and bedding as he shall deem necessary. Total amount of clothing and bedding to be issued shall amount as nearly as practicable to \$30 in value, which amount shall not be exceeded.

Articles.	Chief petty officers, officers, stewards, and cooks.	Bandsmen.	All other enlisted men.
Blue coat	1	1	1
White coat	1	1	1
Overshirt			1
White undress jumper			1
Blue trousers	1	1	1
White trousers	1	1	1
White shirts	1		
Blue cap	1	1	1
White cap	1		
White hat			1
Leggins, pair	1	1	1
Neckerchief			1
Cravat	1		
Blue undress jumper			1
Jersey			1
Overcoat	1	1	1
Flannel shirt	1		
Watch cap			1

DISCHARGES.

t. In time of peace, men shall be discharged upon their own request or by proper authority. When on active service they may be discharged in accordance with Navy regulations.

u. An enrollment record shall be kept in the same manner as an enlistment record, and the health record used shall be the same as the service health record, but shall have written on the face "Naval Coast Defense Reserve" and shall be kept in the same manner as the service health record.

v. During the period of active service an entry shall be made in the health record to indicate the physical condition of the reservist. Upon completion of active service fitness reports shall be made out for officers, enrollment records of men marked, and all forwarded to the commandant of the naval district to which the reservist is attached.

TRANSFERS TO OTHER CLASSES OF THE NAVAL RESERVE.

w. Members of the Naval Coast Defense Reserve may be transferred upon their own application to another class for which they are qualified and may in time of war volunteer for and be assigned to duties prescribed for any class for which they may be deemed by the commandant competent to perform.

L. C. PALMER, *Chief of Bureau.*

NAVY DEPARTMENT,

BUREAU OF NAVIGATION,

Washington, D. C., November 13, 1916.

The stronger and lighter a pulley—the more profitable will be its operation.

But strength and lightness are only two of many features that have built up such a great demand for "American" Steel Split Pulleys—over 3,000,000 having been sold in the past twenty years.

"AMERICAN" Steel Split Pulleys are simply and durably made of high quality pressed steel.

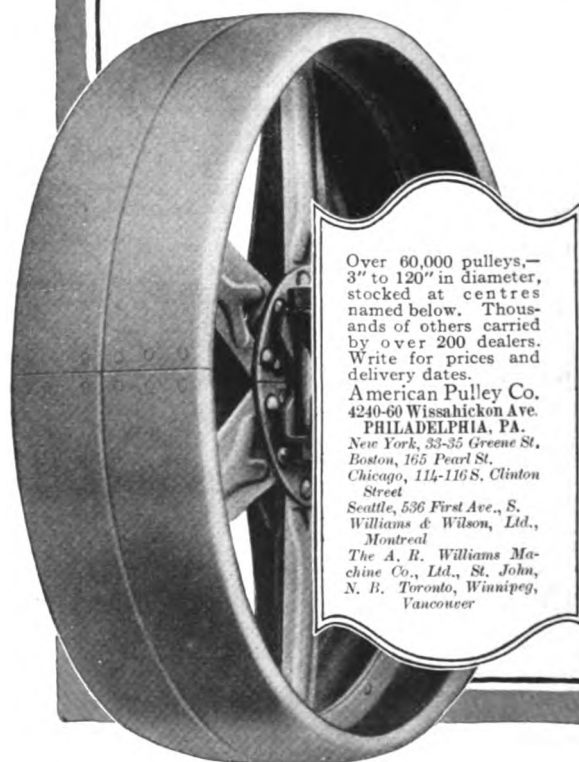
They are easy to install on any line of shafting without the need of keyways or set screws, except where unusually heavy duty is required.

The strongly braced arms are flat, offering but little resistance to air.

"AMERICAN" Steel Split Pulleys are true and well balanced, and will stand unusual strains at high speeds with less belt slip than with wood or iron pulleys.

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AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

EASTERN PENNSYLVANIA CHAPTER

JOHN D. CASSELL, Chairman

GEORGE W. BARR, Secretary, Land Title Building



THE annual meeting and banquet of the Eastern Pennsylvania Chapter of the American Society of Heating and Ventilating Engineers was held at Kugler's Restaurant on Thursday evening, March 8. There was an unusually large and enthusiastic attendance, and the Committee in charge of the entertainment is to be congratulated on having arranged all the details for a most pleasant and successful banquet.

The annual election of officers was held, and the following officers were unanimously elected to serve during the coming year:

President, George W. Barr.

Vice-president, J. T. J. Mellon.

Treasurer, H. P. Gant.

Secretary, George Boon.

The principal speaker on this occasion was Mr. D. Knickerbacker Boyd, and Mr. Boyd's talk was especially appropriate, as he discussed coöperation between the heating engineer and the architect.

Mr. Boyd opened his address by referring to the work being done by the American Institute of Architects through the Structural Service Department in the *Journal*, for which he is preparing and compiling information of special interest to architects and engineers, not otherwise available. He made a plea for assistance from heating and ventilating engineers in preparing such information as might be used to advantage by architects in preliminary work.

"You can always 'tell' a heating and ventilating engineer—but you can't tell him much!" said Mr. Boyd. "But what the architect wants to do," he said, "is to 'ask' the heating engineer, who can tell him a good deal which will be of real value in helping the architect to avoid pitfalls and serious difficulties."

Mr. Boyd suggested that a special committee be appointed from the local chapter of the American Society of Heating and Ventilating Engineers, whose duty it would be to coöperate with the local Sub-committee on Materials and Methods from the American Institute of Architects to promote this spirit of coöperation between the two professions.

Mr. Boyd then went on to say that a better understanding and closer coöperation between architects and all those who furnish materials and perform work on buildings is a matter of the greatest importance, and one which is more generally engaging the attention of the more thoughtful members of our profession.

He said that the letting of heating and ventilating contracts apart from the general contract is a point which should receive serious consideration. This is a broad question, involving equally all trades, and also important gen-

eral conditions in the carrying on of building operations. The practice of a divided contract is not a new one. On the other hand, the practical necessity under certain conditions of general contracts cannot be eliminated. A great help in the cure of the ills complained of, and many others, is the recognition by the architect of his responsibility toward the sub-contractor, as well as toward the general contractor and the owner.

The viciousness of the situation which allows the general contractor to have a bargain sale of contracts as soon as the general contract is awarded to him, regardless of what sub-bids form the basis of his estimate, cannot be too strongly characterized.

In the first place, it is unfair to bona fide sub-bidders, and, in the last analysis, it is detrimental to the owner's interest; for if a sub-contractor cuts his price for work it is inevitable that he will attempt to cut his work to fit the price, just so far as he is able, and, however strict the inspection, its power has a practical limit.

When work is awarded under one general contract the architect can assist and very largely control the whole situation by requiring that a complete list of sub-contractors be submitted with the estimates, the same to be subject to the approval of the architect, and not to be changed without consent after the contract is awarded.

In his own practice, Mr. Boyd said, he invariably does this to protect all interests and insure the selection of capable men, but in the case of heating he practically always takes the estimates direct. He turns over the lowest of these to the general contractor to estimate, with the understanding that they must accept them as sub-contractors' bids if they want the contract.

This gives an opportunity to carefully select bidders—a most important consideration. The men he deems best qualified to do the work of the kind and size in hand only are asked, and the number limited to from three to five.

In some states where the separate contract law obtains, annoyance is often caused because heating, plumbing, and electrical work cannot, when desired, be incorporated in the general contract for state and municipal buildings. If all contracts were separately let, and there were no general contractor, the situation would be quite different; so would it be if, after securing separate estimates on mechanical equipment in the manner indicated, the contractors for these branches of work, upon approval as to their fitness, could become sub-contractors to the general contractor.

While this might cost the owner more, it would insure unified responsibility for completion and term maintenance of the building, and would simplify the course of procedure throughout the work. Under the existing conditions,

contractors are often working at variance, and the way is open for constant dispute and discussion as to interference, delay, responsibility for damage, and defects.

The next step to be taken is one which concerns the most essential of all the practical problems affecting the architects and engineers, namely, to bring about a more thorough knowledge of all materials and methods employed in building construction.

"Your Chapter," said Mr. Boyd, "can coöperate with the architect by keeping the Committee on Materials and Methods of the American Institute of Architects in touch with all that you do to advance the science of heating and ventilating, in order that in due course this information may be summarized for presentation to the members of the Institute and of the profession.

"The Committee will, I feel sure, aim to keep itself as fully informed as possible in regard to your activity, and will need your assistance. It will aim to inform the members of the Institute as to what is being done by all technical and professional societies and other bodies interested in the subject of building construction.

"Not only our associations," he said, "but each of us as an individual can play an important part in this work, and in improving the relations between the architect and the heating and ventilating engineer. As a beginning, let us find some of our faults and set about to remedy them.

"Instead of hopefully waiting for proper methods of estimating to be evolved, let us do our share; namely, in improving them in every way possible. Architects can help greatly in conserving waste of money and human energy in the heating field alone if they will do some very simple things which I suggest that you call upon them to do. Some of these things are now being done by those architects whose first thought is real service to employers—the clients.

"One of these is the preparation of clear and complete drawings and precise specifications which lessen the time and risks taken by the contractors in estimating and which convey to them the assurance that they will not, if they secure the contract, be expected to make up for the shortcomings of the architect.

"I have seen some architects' drawings without figures outside or inside of the plans, and have read some specifications almost as brief as this: 'Heat all portions of the building to 70° in zero weather and guarantee these results.'

"In that large number of everyday cases where no consulting engineer is employed and where the contractor is expected to do his own calculating and engineering and assume all responsibility for results, only to be beaten out,

if he has figured even conservatively, by some one not so scrupulous, intelligent, or careful, the conscientious contractor should refuse to estimate until furnished with a reasonable amount of data on which to base his estimate. He would be performing a distinct service to all good architects, as well as to himself and all thoughtful owners who appreciate the quality of service, if he would state in writing that he would not tender a proposal until all drawings are clear, accurately dimensioned, and fully noted, and all specifications precise, definite, and providing at least minimum requirements.

"Obviously, the architect who makes every heating contractor perform gratuitous calculating and engineering saves himself time, labor, and cost, and transfers these not to one but to a large number of heating contractors and eventually to the owners.

"Of course, for all work of any size it is presumed that the services of a competent engineer have been engaged and the drawings and specifications are prepared with accuracy and precision. Presumably, such a man will be a member of the American Society of Heating and Ventilating Engineers. If not, he should be.

"In addition to what you and the National Association of Steam and Hot Water Fitters have done in perfecting certain practices in piping, and in standardizing flanges, couplings, threads, etc., can you not further your coöperation with the American Society of Mechanical Engineers and manufacturers of apparatus in developing a standard or uniform basis of rating boilers and domestic water heating apparatus, etc.?

"Can you not coöperate with the same society, and work on developing a basic formula, or officially approve one of those in existence, for computing the amount of radiation recommended in proportion to the cubic contents, to outside wall area (for different kinds of walls and different exposures), to window and door openings, etc., and make this available to all architects for instant reference?

"This is a suggestion," said Mr. Boyd, "which I wish you seriously to consider, for I believe it would greatly facilitate common practice in steam fitting, just as piping of buildings for gas will be facilitated by the basic piping schedule just recently adopted by the National Commercial Gas Association, which has been, so to speak, publicly registered in Sweet's Architectural Catalogue.

"I shall be happy if I can feel that anything which I have said may, in ever so small a measure, result in closer coöperation between architects and heating and ventilating engineers in serving the best interests of the American public."

PROCEEDINGS OF THE ENGINEERS' CLUB OF PHILADELPHIA

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Secretary to the Committee on Publication : R. F. VICKERS

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MAY, 1917

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CONTENTS OF THIS ISSUE

	PAGE		PAGE
Committee on Meetings	Inside Front Cover	Addresses presented at Fortieth Anniversary of Engineers' Club of Philadelphia	234
Announcement by J. C. WAGNER, Chairman		Toastmaster—JOHN C. TRAUTWINE, JR.	
Officers, Directors, Standing and Special Committees of Engineers' Club	202	Forty Years Ago	
Committee on Papers	203	By LEWIS M. HAUPT	
Announcement by LEWIS H. KENNEY, Chairman		Franklin Institute	
Secretary's Notices	204	By DR. WALTON CLARK	
Notice of Annual Meeting of Club to be held May 15, 1917		Engineering Democracy	
Business Meeting of the Club, April 17, 1917		By DR. IRA N. HOLLIS	
Special Meeting Board of Directors, April 17, 1917		Philadelphia	
Positions Wanted and Positions Vacant	207	By EDWARD JAMES CATTELL	
Committee on Coöperation for National Defense	208	Philadelphia Association of Members of the Ameri- can Society of Civil Engineers	xi
GEORGE R. HENDERSON, Chairman		American Society of Heating and Ventilating Engineers	251
Committee on Membership	209	Illuminating Engineering Society	252
D. ROBERT YARNALL, Chairman		American Institute of Electrical Engineers	253
Committee on Club Development	210	Technology Club of Philadelphia	253
S. M. SWAAB, Chairman		American Society of Mechanical Engineers	254
Final Report of Committee presented at meeting of Board of Directors and Engineers' Club, April 17, 1917		Duplicate Notice of Meetings for the Pocket	xv
Educational	212	Index to Advertisers	xvi
By J. W. LEDOUX			
Past President, member of Committee on Publication			

Permission is given to reprint any paper after its date of presentation, provided proper credit is given

Contributions of all kinds on all topics of interest to the members of the Engineers' Club are cordially invited. All matter for publica-
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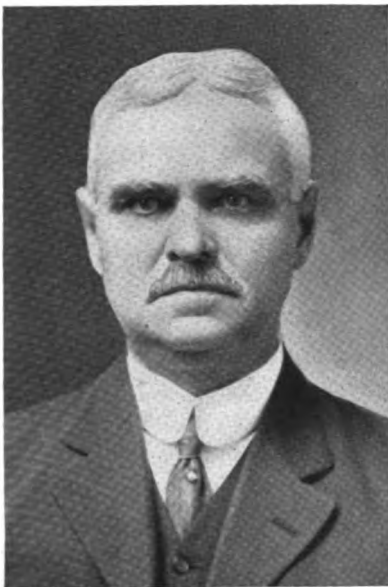
COMMITTEE ON PAPERS

LEWIS H. KENNEY, CHAIRMAN

ANNOUNCEMENT

SPECIAL MEETING, FRIDAY, MAY 4, 1917, AT WITHERSPOON HALL

THE address of the evening, "**The Panama Canal**," will be presented by **Major-General George W. Goethals, U.S.A. (Retired)**, Honorary Member.



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The paper will be illustrated with lantern slides and motion pictures.

Members of Affiliated Societies are cordially invited to attend.

Members of the Club and Affiliated Societies are privileged to invite ladies.

ANNUAL MEETING, TUESDAY, MAY 15, 1917,
AT THE CLUB HOUSE

An address on "**The Engineers' Club of To-day and To-morrow**," will be presented by the President, **Mr. Emmett B. Carter**.



PRELIMINARY ANNOUNCEMENT

June 19, 1917.—*Regular Club Meeting at the Club House.* The paper of the evening will be presented by the **Junior Member** who wins the prize offered by the Board of Directors.

SECRETARY'S NOTICES

THE THIRTY-EIGHTH ANNUAL MEETING of the Club will be held on Tuesday, May 15th, 1917, at 8.15 P. M. The Annual Report of the Board of Directors will be presented at this meeting, and published in the June Proceedings. The final report of the Committee on Club Development, presented at the meeting of April 17th, 1917, will be presented for discussion and action. The annual address, "THE ENGINEERS' CLUB OF TO-DAY AND TO-MORROW," will be presented by the retiring president, MR. EMMETT B. CARTER.

The Report of the Tellers for the Election of Officers for the ensuing year will be presented. Ballots will be forwarded under separate cover. The candidates are as follows:

For *President* (to serve until July 1, 1918), J. A. VOGLESON.

For *Vice-President* (to serve until July 1, 1920), Wm. C. L. EGLIN.

For *Treasurer* (to serve until July 1, 1918), JONATHAN JONES.

For *Directors-at-Large* (to serve until July 1, 1918), R. H. FERNALD, GEO. R. HENDERSON.

ROBERT H. FERNALD, *Secretary*.

ABSTRACT OF MINUTES OF BUSINESS MEETING OF THE CLUB

HELD TUESDAY EVENING, APRIL 17, 1917

The meeting was called to order by President Carter at 8.15 P.M. About 250 members and guests were in attendance. The minutes of the Business Meeting of March 20, as printed in the PROCEEDINGS, were approved.

The Board of Directors elected, at its last meeting, the following to membership: Active, 21; Junior, 1; Army, 1.

A letter from Mr. Thomas C. Desmond regarding the formation of the Roosevelt Division of Troops was read.

Mr. George R. Henderson, Chairman of the Committee on Public Relations, presented the following:

"If it is found necessary to raise a large military force in defense of the nation, we are strongly opposed to a volunteer system which will deplete our industries and public utilities to such an extent as to injure the efficiency of their service, resulting in the difficulties which Great Britain met with in 1914, and against which we have been warned by a number of their most able men.

"We urge the members to seriously consider this, and take up the matter with their Congressmen promptly, in order that some definite action on the part of Congress may follow which will work for the efficiency of the United States as a whole."

Mr. Swaab, chairman of the Committee on Club Development, presented a report, which will be published elsewhere in the PROCEEDINGS (page 210).

Reference was made to the circular letters which have been sent out to the membership to establish a bureau of information for the assistance of the army and the navy.

The paper of the evening, entitled "The Inception and Development of the Submarine Boat," was presented by Mr. John P. Holland, Jr.

A unanimous vote of thanks was extended the speaker. The meeting adjourned at 10.30 P.M.

ROBERT H. FERNALD,
Secretary.

SPECIAL MEETING OF THE BOARD OF DIRECTORS

APRIL 17, 1917

The meeting was called to order by President Carter at 6.45 P.M., with Vice-presidents Vogleson, Yarnall, and Andrews, Directors Murray, Gibson, Crampton, Cassell, Past Presidents Taylor, Swaab, and Ledoux, Secretary Fernald, and Treasurer Irish in attendance. Directors Wagner, Liversidge, Temple, Bullens, and Bachman were absent.

The minutes of the Regular Meeting of March 13, 1917, as issued to the Board of Directors, were approved.

REPORT OF THE PRESIDENT

The President announced the appointment of a Committee on Increase of Membership, with Mr. Edward E. Krauss as chairman, the personnel of the committee not having been completed.

The President also announced the appointment of a Committee on Coöperation for National Defense, consisting of the following:

Guilliaem Aertsen
J. H. M. Andrews
J. A. Steinmetz
Emmett B. Carter (*ex officio*)
George R. Henderson, chairman

The Committee met on April 9 with Captain Harrison A. Bispham, U. S. N., and determined its policy. It was decided to issue letters to the members of the Club and of the Affiliated Societies, enclosing a form to be filled in and returned, stating in what capacity each member would feel best fitted to serve the Government. An index of these replies will be prepared for future use.

SECRETARY'S NOTICES

Action: Board approved the action of the Committee, as above set forth.

A letter from the Society of Civil Engineers of Portugal was read to the Board. The letter requested certain information on the subject of fees allowed civil engineers for professional services.

Action: Secretary instructed to prepare reply.

REPORT OF THE SECRETARY

The following Juniors were transferred to Active membership, as of April 1, 1917, in accordance with authority granted at the March Board meeting:

Henry C. Adams, Jr.	Paul F. Karst
Wm. D. Baker	A. W. Keane
Paul C. Brewer, Jr.	Edwards Kneass
A. K. Cosgrove	Wm. F. B. Koelle
James B. Cutler	Samuel J. Levine
Richard F. Day	Joseph A. McManus
W. Rayner Dean	David J. Matlack
Willard B. Degener	John B. Moran
Clark M. Dennis	William T. Myers
Warren D. Fuller	Emil R. Olbrich
Herman W. Gailing, Jr.	Bartram A. Owen
Jordan Gauthier	Herbert M. Packer
Ralph F. Getz	Samuel H. Pennell
Edwin L. Gibson	J. M. Peterman
Edw. D. Graffin	Ben. B. Roberts
Albert J. Hahn	Earle B. Schaefer
Conard W. Hallowell	Otto F. Schwegler
Thomas E. James	Chauncey H. Swett
E. W. Jones	Stafford R. Webb
A. V. Kaiser, Jr.	Clinton Y. Wilgus

Mr. Benjamin P. Foster, member in good standing of the Philadelphia Section of the American Institute of Electrical Engineers, and Mr. William L. Robertson, member in good standing of the same society, have been elected to Active membership in the Club, March 20, 1917, in accordance with the By-laws.

The following deaths are reported:

Gaston Daus, April 15, 1917.
Edward J. Dimmick, March 13, 1917.
A. E. Lehman, April 5, 1917.
A. W. MacCallum, February 3, 1917.
John P. MacLearn, February 24, 1917.
Wm. H. Hollar, December 11, 1916.

A letter has been received from the Secretary of the Board of Trustees, Pennsylvania State College, requesting the Club to appoint three delegates to the meeting to be held in the Old Chapel, State College, at 2 P.M., June 12, 1917, for the purpose of electing twelve members of the Board of Directors.

Action: President authorized to appoint three delegates.

REPORT OF THE BUSINESS MANAGER

The Board, at its March meeting, authorized Mr. William H. Rau to take a photograph of our Fortieth Anniversary Banquet. Mr. Rau informs me that he

failed to secure a picture of the Banquet, owing to an accident.

The Annual Report is in course of preparation, and can be completed, so far as the reports of the several Committees are concerned, from the reports submitted at the April meeting of the Board. The financial statement can be taken from the Auditors' report.

In the past the reports have been issued to the membership in pamphlet form, and later published in the PROCEEDINGS, without resetting type. It is recommended that the Annual Report this year be published in the June PROCEEDINGS, announcement of this arrangement to be made at the May meeting.

Action: Recommendation approved.

At the present time, there are stored in the various closets in the Club house old letters, bills, books, magazines, etc. In the store-room on the fourth floor are a good many old books removed from the library. Considerable space is required for the storage of back numbers of the PROCEEDINGS. Only a small percentage of the extra copies of the PROCEEDINGS published by Lippincott's are stored here; the remainder Lippincott's are taking care of.

In view of the above, authority is requested to dispose of this material, or that arrangements be made for storage elsewhere than in the Club house.

Action: Board left the disposal of the material mentioned to the direction of the Business Manager, after consulting with the Committee on Library.

It is proposed, as soon as the budget is approved, to establish a book for keeping a record of receipts and expenditures under the several budgets, in order that the officers and chairmen of committees responsible for these budgets can get comprehensive information as to the status of their budgets. Furthermore, it is proposed to provide officers and chairmen of committees with a financial statement the first of each month of their respective budgets.

In the February report of the Business Manager it was suggested that a Committee on Increase of Membership be appointed, with the idea of maintaining our membership and making good the deficiencies caused by deaths and resignations. It is now suggested that a committee be appointed to consider the subject of increasing the affiliated society membership, because there are several societies not yet affiliated with the Club which are eligible for membership.

Action: Board referred this matter to the Committee on Increase of Membership.

In order to establish an operative organization during my temporary service as Business Manager, the following arrangement has been made, which it is requested the Board approve:

Secretary to the Business Manager, Miss S. M. Snedeker, in charge of stenographic staff.

House Manager, Mr. J. H. Shockcor, in charge of house staff.

Assistant House Manager, Mr. F. G. Meily.

ENGINEERS' CLUB OF PHILADELPHIA

Action: Board approved above organization.

It is submitted for consideration that the dues be remitted of members who may serve in the Army and Navy during the present war.

Action: deferred.

An interpretation of Article I, Section 2, defining Army and Navy membership, is requested as to whether or not this applies to members of the Club who obtain commissions in the Army and Navy or Marine Corps during our present war, and whether or not, if transferred to Army or Navy membership, this would continue after the war is over.

Action: It was the opinion of the Board that this section of the By-laws be considered as applying to members entering the service, with the understanding that after being released they automatically return to the class of membership held prior to entering the service.

A contract has been placed with the United States Audit Company for auditing the books of the Club. Work is now in progress.

REPORT OF THE TREASURER

The Treasurer presented a report of the financial condition of the Club.

Action: Report accepted.

REPORT OF THE COMMITTEE ON FINANCE

The Chairman announced that copies of the proposed budget for 1917-1918 had been sent to the members of the Board for their information.

Action: The budget for 1917-1918, as issued to the members of the Board, approved.

REPORT OF THE COMMITTEE ON HOUSE

The Chairman reported that the number of meals served during March was nearly 2900.

Action: Report accepted.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The Committee presented a report, recommending that the following be elected:

To Active Membership:

Edward T. Adams	William S. Nash
Alden W. Baldwin	William Peters
Morris Bradt	William D. Rudy
Walter A. Fleisher	L. F. Sanville
Leigh P. Hoff	Forrest R. Smith
James T. Holmes	Noah B. Smith
Wm. F. Hudson	John H. Tross
Robert B. Krauss	John W. Van Alst, Jr.
John F. McCoy	Edwin M. Wentz
L. Weimer Murray	Henry W. Wetjen
Harry C. Nagle, Jr.	

To Junior Membership:

Walter P. Smith

To Army Membership:

Major Curtis W. Otwell, U. S. A.

Action: Recommendation approved.

The Committee also recommended the election to Affiliated membership of the Worchester Tech Club.

Action: Recommendation approved.

REPORT OF THE COMMITTEE ON PUBLICATION

The Chairman presented a report of the work of the Committee for the past year, to be incorporated in the Annual Report.

Action: Report accepted, with congratulations on the good work of the Committee.

The Chairman requested that the Committee be authorized to publish a comparative abstract of the budgets for 1916 and 1917.

Action: Board approved request.

REPORT OF THE COMMITTEE ON PUBLICITY

The Committee submitted no report.

REPORT OF THE COMMITTEE ON LIBRARY

The Committee submitted no report.

REPORT OF THE COMMITTEE ON PAPERS

The Committee presented a report of its work for the past year for incorporation in the Annual Report.

Action: Report accepted.

REPORT OF THE COMMITTEE ON MEETINGS

The Committee presented a report of its work for the past year for incorporation in the Annual Report.

Action: Report accepted.

REPORTS OF SPECIAL COMMITTEES

Committee on Public Relations

A communication was presented from Mr. Thomas C. Desmond, with reference to the formation of a division by Col. Theodore Roosevelt.

Action: Board requested that Mr. Henderson read this communication at the Club meeting later in the evening.

The Chairman submitted a report, calling the attention of the Board to the necessity for opposition to a volunteer system which will deplete our industries and public utilities to a harmful extent.

Action: Report approved and recommendation made that the Chairman read the report at the Club meeting later in the evening.

Committee on By-Laws

The Committee presented a report of its work for the past year for incorporation in the Annual Report.

Action: Report accepted.

Committee on Club Development

The Chairman submitted a detailed report, showing the proposed financial program providing for the purchase of the property adjoining the Club at 1315 Spruce Street.

SECRETARY'S NOTICES

Action: The Board requested that this matter be presented by Mr. Swaab to the Club at its meeting later in the evening as the recommendation of the Board to be discussed at the next regular Club meeting and published in the May PROCEEDINGS.

Committee on Club Banquet

The Committee presented a report of the Banquet held March 30.

Action: Report accepted and the Committee dis-

charged with the thanks of the Board for the successful conduct of the Banquet.

Trustees of the Bond Redemption Fund

The Chairman presented a report of the Trustees for the past year for incorporation in the Annual Report.

Action: Report accepted.

The meeting adjourned at 7.45 P.M.

ROBERT H. FERNALD,
Secretary.

POSITIONS VACANT

Those in need of competent and experienced men will find it to their advantage to make their wants known through these columns. The Secretary of the Engineers' Club is constantly in touch with men capable of filling positions in all branches of Engineering. No charge is made for this service.

Wanted: Civil engineer, graduate with two or three years' experience in Mill Structures; steel, brick and concrete building and estimating.
Apply Engineers' Club, No. 145-A.

Inspector wanted: Experienced in expediting machinery deliveries. Apply in writing giving particulars, experience, etc.
Apply Engineers' Club, No. 140-A.

Chemist wanted, familiar with the analysis of fuel oils, apparatus used in conducting boiler tests, some knowledge of steam engineering and methods of conducting evaporative tests of steam boilers.
Apply Engineers' Club, No. 141-A.

Manufacturer has opening in selling organization for engineer experienced in steel ship construction; capable of handling sales details technically and with acquaintanceship among the engineering and hull designing staffs in eastern yards. An excellent connection for man properly qualified. Address, giving full particulars, Engineers' Club, No. 143-A.

Wanted: Clerk of work for a large building operation. Must be able to handle instruments. Young engineer preferred. State age, experience and salary expected.

Apply Engineers' Club, No. 142-A

Wanted: A mechanical draftsman. Salary according to ability. Apply Engineers' Club, No. 139-A.

Wanted: Sales engineer, to sell power plant equipment apparatus. Must be technical graduate, and a man of good address, with an extensive acquaintance in the Philadelphia districts. Replies to be considered must state full experience, education, age and a complete business history of the applicant, together with salary expected. Excellent opening for the right man.
Apply Engineers' Club, No. 144-A.

Wanted, man who has had practical experience in every branch, such as shop work, drawing-room work, tool designing; must be informed in modern cost and planning department methods; electrical manufacturing experience preferred. Vicinity of New York—concern manufacturing metal products.

Apply Engineers' Club, No. 146-A.

POSITION WANTED

Mechanical engineer. Stevens Institute, 1912. Several years' shop experience, steam railroads. Two years as general mechanical draftsman. Prefers position outside drawing-room. Apply Engineers' Club, No. 139.

COMMITTEE ON COÖPERATION FOR NATIONAL DEFENSE

GEORGE R. HENDERSON, CHAIRMAN

Early in the month of April, the President of the Club appointed a special Committee on Coöperation for National Defense, and after a meeting of organization on April 9, the following letters were sent to all the members of the Club and Affiliated Societies, urging them to fill in the blanks and send them to the Club, thus signifying their willingness to assist the Government at this critical time.

The letters speak for themselves, and it is hoped that those who have not responded will at once send in their blanks, properly filled out for future reference. In recent conference with a prominent naval officer, he stated that he knew of no way in which the Club could be of more assistance to the Navy than in compiling a professional inventory of engineers who were willing to help and could be obtained on short notice when emergency required their services. Army officials have expressed similar views.

THE ENGINEERS' CLUB OF PHILADELPHIA

1317 Spruce Street, Philadelphia, Pa.

April, 10, 1917.

TO THE MEMBERS OF THE ENGINEERS' CLUB AND AFFILIATED SOCIETIES:

In order that the Club members may be kept in touch with the requirements of the Government, I have appointed a Committee on Coöperation for National Defense, consisting of the following :

GEORGE R. HENDERSON, *Chairman* G. AERTZEN
J. H. M. ANDREWS JOSEPH A. STEINMETZ

Enclosed is a statement prepared in conference with a representative of the Army and the Navy.

It is requested that the members fill in the enclosed blank form and return immediately.

In connection with this matter, it is particularly desired to draw attention to the movement at present under way to form an additional engineer unit for the Pennsylvania Division of the National Guard. The Engineers' Club is at present represented in this division by Company B, Engineer Battalion, which was organized in the Club and has been largely recruited from the Club membership. The proposed new unit from Philadelphia should be composed of men of the same high class as comprises the membership of Company B, and it is hoped that there will be a large response from among our younger members to the appeal for recruits for this organization. The large demand for engineer troops in the armies which are to be formed makes this service particularly attractive. Men entering National Guard units are more likely to see service than are men entering volunteer organizations.

Circulars relating to Aviation in connection with the Army, Navy and Marine Corps Service are being prepared. In the meantime, it is suggested that any man who desires service of this sort get in touch with the Signal Corps of the Army.

Circulars relating to service in the Army, Navy and Marine Corps are in course of preparation, and will shortly be issued to the membership.

Very truly yours,

(Signed) EMMETT B. CARTER, *President*.

COMMITTEE ON COÖPERATION FOR NATIONAL DEFENSE

The Engineers' Club of Philadelphia

TO THE MEMBERS OF THE ENGINEERS' CLUB AND AFFILIATED SOCIETIES:

On page 169 of the "Proceedings" of the Engineers' Club of Philadelphia for April, there appeared some correspondence and papers regarding the service which members of the Club as engineers could render their country in the present emergency.

Captain Ridley, of the War Department, and Captain Russell, of the U. S. Navy, furnished information regarding service in the Reserve Corps, and it is hoped that many of our members will volunteer for active service, either in the regular or reserve forces.

There are many engineers, however, who would be barred for such duties by reason of age or physical limitations, but who could render important service in their particular spheres of activity, and, in order to make those services quickly available when necessary, it is desired that each member who is willing and able to assist his country will promptly answer the questions on the enclosed sheet, and mail to the Committee for registration and indexing.

G. AERTSEN E. B. CARTER
J. H. M. ANDREWS J. A. STEINMETZ
GEO. R. HENDERSON, *Chairman*

April 10, 1917.

CONCLUDED ON NEXT PAGE

SARA M. SNEDEKER, *Secretary to The Committee*.

COMMITTEE ON MEMBERSHIP

D. ROBERT YARNALL, CHAIRMAN

CANDIDATES FOR MEMBERSHIP

Members having knowledge of the candidates are invited to submit to the Committee on Membership before May 7 a confidential expression of opinion as to the eligibility of the candidates; all communications to be addressed, "Chairman of the Committee on Membership, Engineers' Club, Philadelphia," marked "Confidential."

All applications are on file at the Club and can be referred to by any member.

SAMUEL HOAG CORNELL

67 W. 83rd St., New York City.

In Chief Engineer's Office, New York Shipbuilding Co.
Proposed by James S. Malseed and W. A. Leavitt, Jr.

TOM C. MAHADY

6222 Catherine St., Phila., Pa.

Representative to Architects and Engineers.
Proposed by G. Harris Britt and Richard C. Newbold.

LAWRENCE B. MANLEY

748 Bourse Bldg., Phila., Pa.

Division Engineer, Dept. of City Transit, Phila.
Proposed by Alfred A. Townsend, Fred C. Dunlap and Stephen Harris.

LEWIS FERRY MOODY

I. P. Morris Co., Phila., Pa.

Consulting Engineer, I. P. Morris Co.
Proposed by Frank H. Rogers, John Overn, Jr., L. H. Kenney.

WILLIAM FRANCIS O'BRIEN

2005 Finance Bldg., Phila., Pa.

Safety Engineer, Penna. Mfrs.' Association Casualty Insurance Company.
Proposed by J. Maurice Peterman, Gregory C. Kelly and Adam C. Warfel.

CLARENCE B. ROGERS

3309 Powelton Ave., Phila., Pa.

Mechanical Dept., Wm. Steele & Sons Co.
Proposed by William G. Otto and F. M. Yewdall.

ELMER P. RUST

Care of C. H. Wheeler Manufacturing Co.

Testing and Research Engineer.
Proposed by John A. Bannard and Fred B. Barns

ROBERT CLARK WHEELER

26 S. 3rd St., Phila., Pa.

Civil Engineer, Acting General Manager New Chester Water Company.
Proposed by George W. Fuller and Charles B. Buerger.

FOR ELECTION TO JUNIOR MEMBERSHIP

G. LINDSAY MacGARRIGLE

218 Zeralda St., Gtn., Phila., Pa.

Clerk in Microscopical Laboratory Midvale Steel Co.
Proposed by W. M. Mitchell, A. H. Miller and John P. Mudd.

CONTINUED FROM PRECEDING PAGE

COMMITTEE ON COÖPERATION FOR NATIONAL DEFENSE

The Engineers' Club of Philadelphia, 1317 Spruce Street

Residence..... Occupation..... Business Address.....
Date of birth..... Place of birth..... Father's nationality..... Mother's nationality.....
Citizenship..... Physical condition.....
Education..... College..... Degree.....
Years in active practice of profession..... Any motor boat experience.....
Membership in Engineering and Scientific Societies.....
Willing to join Army, Navy, Marine Corps, Army Reserve, Naval Reserve, Aviation Corps, or new Engineers Company of
National Guard of Pennsylvania.....
Willing to assist Government professionally as.....
Particular work preferred..... Could commence activities.....
References.....
Speak or read foreign language..... Detail of experience.....
Date..... Signature.....

COMMITTEE ON CLUB DEVELOPMENT

S. M. SWAAB, CHAIRMAN

FINAL REPORT of Committee presented at Meeting of Board of Directors and Engineers' Club, Tuesday, April 17th, 1917.

THE Engineers' Club of Philadelphia exists because it is recognized that the dissemination of knowledge pertaining to Engineering and the interchange of ideas affecting the profession can best be effected through organization and also by reason of the fact that the Engineer being a normal animal is not fitted to live alone, and for this reason seeks the company of others of like tastes and interests with whom he desires to share his stay on this earthly sphere.

Like any other organic body the Club has passed through several successive stages in its growth and evolution resulting finally in a mature product requiring a suitable environment to best serve the ends for which it came into existence.

The Club, composed of a representative membership of the local engineering profession, has made for itself a distinct place in the community and it is or should be our object to extend its sphere of usefulness.

This being the case the Committee on Club Development after a thorough canvass of the situation feels that the Membership should be apprised of its conclusions regarding improved housing facilities, which subject has been under consideration for some time.

On Friday evening, March 30th, 1917, at the Fortieth Anniversary Banquet of the Club, at the Hotel Bellevue-Stratford, the Chairman of your Committee in the course of an after-dinner address, presented in concrete form the hopes, the aspirations and what the Development Committee thinks to be the desideratum in this matter.

It is acknowledged by all concerned that the present quarters are inadequate and congested and incapable of utilization to the fullest extent by the Membership by reason of this.

Of course in providing larger and more adequate and commodious quarters our ultimate choice is dictated principally by the amount of dues which the Membership feel disposed to pay, at this is our principal source of revenue.

The financial status of the Club is not better today than it has been for many years past, nor is it materially worse. Due to the fact that because we have kept our dues as low as they are, we have never been able to lay anything aside and we are, therefore, to use a current expression, in a state of "unpreparedness." Suffice to say that for the past twelve months we have been sailing very close to the wind and it is time that we should disillusion ourselves and come to a thorough

appreciation of the actual conditions, and be assured of the fact that with our present dues it will be impossible for us to more than make some very minor and much needed repairs to the present Club House and it is, moreover, entirely out of the question to make any extensions whatever.

Due to the facts herein set forth, the course of our sailing has not been overly smooth and while we have not gone on the rocks (which to some extent has been prevented by skilful sailing and more skilful steering) we have for some time past felt with the immortal Shakespeare (Heaven forbid that I should misquote him) that "There is a Divinity that shapes our ends rough-hew them as we will." The undoing of this condition is in our hands and if an earnest effort is made to relieve it there is no doubt of the fact that ultimately we will be successful.

A slight increase in dues will permit us to secure the premises immediately east of the Club House and convert it so that together with our present house we will be in possession of a plant which will be quite adequate for some years to come. The premises at 1315 Spruce Street can be purchased for the sum of \$35,000, on which it will be necessary to make a first payment of \$15,000 and the balance can remain on mortgage. Having been for many years used as a private residence, this house will require remodelling to transform it into a suitable addition to our Club House. To make the first payment on the property and to make the additions and alterations and subsequently furnish the house will require the expenditure of upwards of \$46,000, and while this is not an inconsiderable amount it should be taken for granted that with as extensive a membership as we now have, we should be well able to procure it.

The membership should know that if this property is developed in the way it is thought possible to develop it, it will to a large extent do away with the overcrowding which exists at the present time and also provide us with additional sleeping quarters so that we will ultimately derive considerable revenue therefrom, and while the Committee does not care to go on record as saying that the revenue derived from these quarters, plus the amount of money which we may save by reason of the fact that we expect to provide an auditorium of ample size so that we will not be required to hold our meetings outside very often, in the future, may to some extent pay the carrying charges on this investment.

When everything is considered, the proposition presents a very satisfactory aspect. In the first place our present quarters are too small for our membership. Second—It is our desire to not alone retain the membership which we have, but to increase it. Third—The dues which we are now paying are insufficient to provide ample quarters for the present membership and fourth—In order to provide such quarters it will be incumbent on us to slightly increase our dues and provide the wherewithal for the purchase of the property in question.

TENTATIVE FINANCIAL PROGRAM.

1st—Issue 1000 shares stock or notes at \$25.00; guaranteed interest at 4 per cent.	\$25,000.00
2d—Issue 5 per cent. bonds on 1315 and 1317 Spruce St., and additions and betterments	15,000.00
3d—Issue Life Memberships, 20 @ \$300	6000.00
Total amount authorized	\$46,000.00
First payment on 1315 Spruce Street to be made from	
stock sales	\$15,000.00
Alterations (estimated)	18,000.00
Furnishings (estimated)	5000.00
	\$38,000.00
Surplus	8000.00
	\$46,000.00

ANNUAL CHARGES.

Stock dividends 4 per cent. on \$25,000	\$1000.00
Interest on bonds 5 per cent. on \$15,000	750.00
Interest on first mortgage \$23,000 @ 5.4 per cent.	1242.00
Taxes, 1315 Spruce Street, \$35,000 @ \$1.75	612.50
Water rent, 1315 Spruce Street	100.00
	\$3704.50

To meet the annual charges will in itself require a nominal increase in dues, but to provide for the ordinary upkeep and for sinking fund charges and to retire the bonds at maturity will probably require say \$5000 per annum, which can readily be carried by \$20 dues. This is in the judgment of our Committee the minimum increase in dues, which will allow us to put through the scheme which we have under consideration. This does not take into consideration any additional operating charges, as these can probably come from revenue derived from lodgings, etc.

1st—Sell stock or notes in excess of \$12,000	\$12,000
2d—Issue Bonds to cover investment in 1315 Spruce Street	15,000
3d—Sell balance of stock or notes	13,000
4th—Issue Life Memberships	6000
	\$46,000

We can proceed with items 1, 3, and 4 simultaneously. Item 2 can only be prosecuted after at least \$12,000 has been secured under items 1 and 3.

It may be asked why we are issuing obligations both in the shape of interest bearing notes, and bonds, in the order named, and the reason is simply this, that to issue the latter we must have some tangible asset which we do not now possess and which we hope to secure by making the first payment on the property with money secured by the issuance of interest bearing

notes, which have not necessarily any security in the shape of realty or other tangible thing, but which nevertheless are a moral and legal obligation on the part of the Club to pay, and also were we attempting to dispose of the bonds to the general public we could not issue them to the full amount of our equity in the property nor would the proposed rate of interest be attractive, but it is hoped that the membership will not be so fastidious and will readily assist in furthering the proposed scheme to the extent of their financial ability. It should also be said that the value assigned to the life memberships does not represent the "present worth" of the Club dues for a given period at a stated rate of interest as is usual, but is entirely arbitrary.

The securities to be issued by the Club on which it is intended to raise the money that is required to make the first payment, etc., on the property in question, are to be offered the membership at par value on such terms and in such installments as may be arranged between the Club Members and a special Finance Committee representing the Board, having this matter in charge. They are purchasable if, when and as issued in current coin of the realm, in such installments as may be mutually agreed upon, and the Club dues, while they are to be considered as annual dues, are to be payable hereafter in two semi-annual installments.

As the fundamental reasons for which this Club exists, as set forth in the body of this report, are practically the same as those affecting any other organization, viz., the rendering through organization of the greatest good to the greatest number, it is hoped that the membership at large will see that this can only be accomplished by entering whole-heartedly into this scheme and rendering all of the assistance, mental, moral and financial, as each individual member shall determine for himself. On the other hand no man is asked for a direct contribution, although these also will be acceptable, but in a much broader sense, no man is asked to purchase any of the securities offered by the Club, unless he feels in such a position financially that he can do it without affecting his condition.

The Board feels at this time that we should not ask for a contribution from anyone and certainly that we should not go outside on a general money raising campaign. However, we do feel that the proposition outlined in this report is conservative and rational and the members are getting exactly what they are willing to pay for, i.e., a quid pro quo, or in common parlance they will get just what is coming to them.

The Committee in presenting this, their final report, feel that they have successfully accomplished the task assigned them and now look to the Club Membership at large, acting in conjunction with the proper officials, to take up the good work and carry it to a successful issue.

Respectfully submitted,

For the Committee on Club Development,

S. M. SWAAB, *Chairman.*

EDUCATIONAL

J. W. LEDOUX

PAST PRESIDENT, MEMBER OF COMMITTEE ON PUBLICATION

THE subject of education is universally recognized to be of transcendental importance. In the United States formerly the plain people looked up to the three learned professions of law, theology, and medicine as the only sufficient reason for the college, and believed that a good common-school education, such as was attempted in every country school, afforded a sufficient preliminary preparation for all other lines of activity. Some few institutions had courses in the sciences, such as applied mechanics and engineering, chemistry, etc., but it was generally recognized that practical results and proficiency were only attainable by time-serving and apprenticeship with men experienced in each particular line of industry. That is probably why the technically trained college man has heretofore been contemptuously referred to as a mere theorist and greatly inferior to the "practical man."

Then it began to be seen that a thorough and fundamental training in the sciences provided a substantial and essential basis for the most rapid progress and the acquisition of resourcefulness in the development of the various arts and industries, induced by the growing desires and tastes of society.

To become expert and eminent in any line of work it was seen that incessant effort was required for the best part of a lifetime, and therefore the necessity for specialization commenced early in life was obvious.

The past half-century has demonstrated that the greatest human progress of the world has been due to the designs and discoveries of scientific men, and even the present world-war is being fought essentially by scientific methods and devices. In fact, it is hard to find any sphere of human activity wherein scientific training does not exert a controlling influence. But, while the surface has only been scratched, the available and essentially useful knowledge of the sciences is now so vast and various that if all schools confined themselves to nothing else each pupil could in the ordinary maximum studying period obtain a fair mastery of only a small proportion. Yet so strong is tradition that even the great standard universities require their students to spend years in the accumulation of obsolete and relatively unimportant knowledge—histories that are as well forgotten, smatterings of languages that are not likely to be useful, and some that are no longer spoken.

Even among experienced educators of high char-

acter and intelligence there is no agreement as to what the college attitude in education should be; judging by some of their learned addresses, it would not be hard to get the impression that they believe the best plan is to adopt the newspaper idea—find out what is most popular, particularly with men of influence, and take that as a standard.

Another plan that seems to have some following just now is to try and discover and teach those qualities that enable men to command positions of responsibility and high incomes, realizing that living testimonials furnish the most lucrative advertisement possible to obtain, and that the success of the institution is of more immediate and practical advantage than the ultimate benefit which the said institution might be to society. Many a near Watt, Otto, or Edison is diverted from his course by the prospect of social popularity or executive success. The man might have accomplished wonders in mechanical or chemical achievement, but he was too good a quarter-back or base-ball pitcher to be given up to technical research.

To listen to the conversation of the average undergraduate, one unacquainted with college life might suspect that intercollegiate sports and the latest fads constituted the most important part of the college training. However, there are in every college ambitious students with fixity of purpose to prepare themselves well to afterwards do their share of the world's work. And these are the men who subsequently reflect honor upon their alma maters.

While the courses are restrictive and probably omit some things of vital importance and include others of no practical value, the present college is far better equipped than ever before to aid the earnest worker in his endeavor to obtain a worth-while education.

One college prides itself on its moral standard, the suppression of snobbery, and the development of high-toned character; another upon the profound thoroughness of its technical training; another upon its reputation for turning out men proficient in English; another upon the initiative, resourcefulness, and practical ability of its graduates; another upon the enthusiasm and interest possessed by its students. Another looks upon personal hygiene, health, and physical excellence as of greater importance than all the rest. While a combination of all these qualities might be considered ideal, the degree of attainment

must necessarily depend upon the composite standard of all the teachers and students, which in turn depends upon the viewpoints previously acquired; and thus educational methods, like other arts, may be progressive and evolutionary.

Some one has said that the college does not make the man, but the man makes the college, so those who are going to make their mark in life will in all probability do so, whether they go to this, that, or no college. Every such man who spends four years in a college leaves an indelible impress of his influence and example for the lasting benefit of the institution.

After all, it is generally found that the attainment of true greatness in any line of activity is due less to brilliancy than to an extraordinary capacity for hard and continuous work, and no matter how excellent is the college training there are no easy short cuts to worth-while achievement.

The writer has often thought that the basis of the best education is indicated by a consideration of the fundamentals. The laws of nature are unchangeable and eternal and account for all phenomena. A knowledge of these laws constitutes the greatest wisdom. Histories of the fleeting and ephemeral events and customs of the present and past are only of value as they aid in the discovery of these fundamental truths; hence the importance of scientific education.

One reason why educational experts may not agree on what should be essential is that they have different viewpoints. Whether the education is considered from the standpoint of its profit to the individual or to society will make a great difference in the adopted curriculum. In the former case so-called cultural studies may be more essential than the fundamentals: a cultured accent, a well-selected vocabulary, and an air of elegant refinement are of great intrinsic value to the possessor, but generally of little value to society. On the other hand, if it be admitted that the study of fundamentals furnishes the true basis for the best education, then cultural training must be considered in the nature of a diversion, and more adapted to men of leisure than to those who are doing the necessary work of society.

It is very true that the class of ability that at first sight appears to have no bearing on the fundamental education herein touched upon often commands the highest market value. An advertiser, a salesman, or a promoter who is successful in influencing the holders of wealth to invest in a proposition frequently can obtain a greater income than the man who conceives the proposition, and it is often flippantly stated by such a man that he can hire scientifically trained men for a very small stipend.

However, the services of such a promoter when engaged in advancing a meritorious proposition may be of the highest order, and are somewhat analogous to that of

the engineer, who conceives and carries out a plan for transmitting power from a distant source to where it can be used to operate the wheels of industry. In fact, the education of the scientist or engineer is never rounded out and complete until he is able to promote his own plans and conceptions better than anyone else.

Finally, that education is best which most effectually causes the possessor to leave society better off by reason of his lifetime activity than it was before he existed.

P U B L I C S C H O O L S

Philadelphia is particularly well favored as an educational environment. The city public school system comprises 205 elementary schools, with an enrolment of 199,498; ten high schools, with an enrolment of 17,025; two normal training schools, with an enrolment of 724; one trade school for boys, with an enrolment of 524; and in connection with many of the schools there is what is known as the "continuation system," whereby children under 16 years of age, while engaged in other work, are obliged by law to attend school at least eight hours a week during the school period. There are 10,000 such continuation students. The number of graduates during the year 1916 in the schools above the elementary grade was 2150.

T E C H N I C A L A N D H I G H E R E D U C A T I O N

The Spring Garden Institute provides facilities for technical education, the study of machine design, manual shop practice, architectural work, mechanical and freehand drawing, electrical and automobile courses, the sessions being held mostly at night. The enrolment is 950 students. The price of tuition is very low and the courses last from two to four years.

The Franklin Institute provides facilities for night courses in mechanical and freehand drawing; higher education in mathematics, mechanics, machine design, naval architecture, etc. The enrolment is about 350 students, and the price of tuition is also very low.

U N I V E R S I T I E S A N D C O L L E G E S

Some of the more important educational institutions within and close to the city are University of Pennsylvania, Bryn Mawr College for Women, Swarthmore College, Haverford College, Temple University, Villanova College, Drexel Institute, Girard College, and Williamson Trade School.

While these institutions differ materially in rank and curricula, and therefore are not comparable, each possesses great merit in its own line.

We have been fortunate in securing the following articles from representatives of several of the institutions above enumerated.



MEMORIAL TOWER
UNIVERSITY OF PENNSYLVANIA

THE UNIVERSITY OF PENNSYLVANIA

ITS PURPOSES, ITS AIMS AND IDEALS

A FEW years ago Dr. J. William White, as chairman of a Sub-committee of the Board of Trustees of the University, stated that the University aims to be able to say not only that it is maintaining a good position in a race in which many are engaged, but that in important respects it has a different objective from other institutions, and that it has worked out its own way of reaching that objective. With these ideas in mind, the general purposes of the respective departments were expressed by the Deans partly as follows:



DR. EDGAR FAHS SMITH
PROVOST, UNIVERSITY
OF PENNSYLVANIA

In the past the College of the University of Pennsylvania has contributed to the University the three qualities for which the University stands; that is, liberality, individuality, and democracy. Pennsylvania stands also for the development of individuality. Gathering her students from all the countries of the world, the broad cosmopolitanism of the student body is itself an education, and we have always endeavored to preserve the note of personality which is so precious. This fact—

that the College is part of a large University—gives it certain advantages: (a) A large faculty with specialists in their several departments. In a small college the students would be limited to two or three teachers in each subject—while at Pennsylvania the college student has the advantage of coming in contact with six professors of English, five of history, etc.; (b) the material equipment; (c) the cosmopolitan tone, due to the presence of so many nationalities. At the same time, owing to the relatively small numbers in the College, the personal intimacy between teachers and students, which is invaluable, is possible in a way that is out of the question in a university where the college is also large.

The underlying object of the Towne Scientific School is *the making of men* by the proper training of character, so that those who graduate from it will be not merely machines capable of accomplishing certain things, but individuals having ideas and ideals acquired during the four years spent at the University, while their characters were in process of development, and while, as young men, they were susceptible to such influence for good as the teachers were able to surround them with. The aim

is to turn out men possessing trained minds with which to solve the problems that are to confront them rather than to have them think that by applying certain formulæ which they are told to learn they will be able to solve such problems.

The general purpose of the Wharton School of Finance and Commerce is primarily that of affording a good general education of the type that is regarded as most satisfactory by way of preparation for business and citizenship. What we wish to do is to open up to students a knowledge of the best thought of the world in literature, science, and philosophy, to develop appreciation of these things as well as a scientific and philosophical attitude of mind. The type of work most emphasized is not merely the basis of satisfactory training for business, but the basis of satisfactory training for life.

The aim of the School of Education is to train teachers professionally for teaching in high schools, and to prepare school superintendents and supervisors of education.

The mission of the Graduate School is to train scholars who shall be fitted to become teachers and experts in their chosen fields of study, and to promote research on the part of both the student body and the faculty. The Graduate School aims to train advanced students in such a way that they may be fitted to become the educational leaders not only in universities, colleges, and secondary schools, but also in other fields of activity where the services of scientifically trained experts are required. It is the peculiar function of the Graduate School not only to give its students command of the ascertained facts in the special fields they may elect, but also to train them in scientific methods so that they may add to the sum of knowledge and become productive scholars.

It is the purpose of the Law School to offer an opportunity to the undergraduate to secure a training which will equip him to practise law with efficiency; to surround the student with an influence which will cause him to appreciate the importance of those rules of conduct which experience has shown are necessary to the performance by the profession of its duties toward court and clients, and to maintain that respect for the administration of justice which is essential to public welfare; to give the student knowledge of the problems relating to the adaptation of the organization of the court and procedure to modern conditions; to encourage legal analysis and research by attracting men of ability as graduate students; to have a faculty composed of men recognized as authorities upon their respective branches, and to encourage relations with the national, state, and local governments which will result in public officials turning to the Law School for expert assistants in constructive legal work.

The Medical School aims to cultivate a wholesome desire among the faculty to work for the best interests of

the school over and above all thoughts of self; to set students an example to be imitated throughout their future careers as physicians, and to teach them while in the school so that they will be able to go anywhere or to do anything in a medical way that could be expected of a recent graduate; to thoroughly ground the men in the fundamental medical and surgical principles on which subsequent specialization must be based, with as much practice in the direct application of these principles as the clinical material and the limited time afforded to each subject will permit. The teaching is noteworthy as contrasted with other institutions from the free use of the unusually rich clinical material afforded by the large services of the University and Philadelphia Hospitals, both practically on the campus of the University.

It is the aim and ideal of the Dental School to train its students so that they shall become efficient practitioners of dentistry in the sense that they shall be equipped to deal with mouth conditions from the broad viewpoint of their relationship to bodily health not only as related to the individual case, but from the public health viewpoint; to thoroughly train students in a knowledge of the composition, structure, and function of the body as a whole, so that his ideal shall be that of a medical specialist dealing with an important part of the field of bodily nutrition.

The Veterinary School aims to prepare its graduates

for service as private practitioners, as official veterinary sanitarians, and as dairy and meat inspectors, and to afford facilities to the graduate who may desire to pursue advance work in any of the major veterinary subjects in preparation for research work or teaching so that he will have a broad foundation upon which to build.

The statement of the aims and purposes of the nine University schools set forth above has necessarily been much abridged for the purpose of this article. In summarizing the statements as originally presented by the various deans, the late Dr. White stated that the ideal of the University work, taken as a whole, is not merely to turn out men who have, while at the University, acquired a certain sum of information, either general and making for broad views of life and its problems—*i.e.*, "culture"—or special and applicable to a particular business or profession. The ideal is rather to teach our students to use their brains logically and intelligently—to think "straight," and then to enter on the real work of their lives, fitted for successful endeavor and accomplishment.

Anything that will enable the University more effectively to live up to this ideal and thus to influence for good these great numbers of young men, and, through them, a vastly greater number of others with whom they will have relations, is a public benefaction of the highest value and importance.

THE DREXEL INSTITUTE

THE Drexel Institute came into being twenty-five years ago through the great-hearted vision of Anthony J. Drexel. Born and bred in Philadelphia, this modest, kindly, patriotic gentleman desired to build in the old city that he loved an institution which should enable young people, in his own words, "to lead useful and happy lives." He believed that a primary need of the good citizen was the ability to earn a living in a specific vocation, and he provided the Institute with the equipment needed for the best types of instruction in engineering, in domestic science and arts, and in secretarial studies. But he went further than this, and, in a day when technical education was to a great extent narrow and formal, he foresaw the educational trend of a quarter of a century later, and recognized that, in a democracy, training for citizenship and service was the only safe foundation for vocational knowledge.

In the pursuit of that aim and of his desire to provide the means for a happy as well as a useful life, Mr. Drexel



DR. HOLLIS GODFREY
PRESIDENT
DREXEL INSTITUTE

surrounded the shops, recitation rooms, and laboratories, where students were to be fitted with specific knowledge, with all those requisites for development which the civic thought of today recognizes as essential. The modern city recognizes the need of open-air playgrounds, of picture galleries, of music, and of all activities that make for enduring character and for a high order of citizenship. Mr. Drexel, twenty-five years ago, foreseeing these civic needs, gave to the Institute all those opportunities which modern city planning is striving to provide. The great court, the great organ, the gallery of originals of modern masters, the library with its combination of belles-lettres and of technical work, the playing fields, the noble corridors, and rich collections—given not only by Mr. Drexel, but also by his close friend,

Mr. Childs—all make a city beautiful in miniature, which yields great returns in its silent training for citizenship.

This is, however, a day of educational questioning.

"*Quo Vadis?*" is the question asked of all the institutions which are training the youth of America in the time of mighty change. Splendid though the background of any institution of learning may be, high ideals and purposes, clearly defined, alone will give vitality to daily tasks, to citizenship, and to service. Such definition of institutional ideals and purposes is difficult, but it is attempted here.

The Drexel Institute stands in American education for the recognition of the value of technical training joined to the appreciation of all the factors which give the possibility of right living and of a maximum capacity of service to the good citizen. Its primary purpose is to train men and women thoroughly and practically for their life tasks in three specific lines. But it recognizes to-day, as it has always recognized, that imagination is a most powerful tool in the hand of every worker, and that the progress of American commerce and industry is essentially dependent upon the imagination and civic devotion of trained minds.

In the Institute courses, the specific training in the chosen vocation is supported by fundamental training. No technically trained worker of any type is effective unless he can express himself simply and clearly orally and in writing, unless he can use pure mathematics and pure science as keys to unlock applied mathematics and science, and unless he is given some opportunity to work with his comrades towards common ends and to develop community spirit as opposed to a self-centered individualism. The Institute finds its distinctive field in the

balanced development of the useful citizen by thorough, practical, specific training in one of its three schools, supported on the one side by fundamental training in the basic arts and sciences and on the other by carefully chosen social and community activities.

The work of the Drexel Institute, as already noted, is limited to the intensive development of three main branches of learning, but in none of these does it compete with other institutions of collegiate rank in Philadelphia. In Engineering, for example, its four-year course leading to the degree of Bachelor of Science in Engineering develops the special theory of preparation for the great field of general engineering, while students desiring instruction in the more specific types of engineering are referred to the University of Pennsylvania. In like manner, the courses in the School of Domestic Science and Arts and the Secretarial School are markedly separate from any courses in these branches offered elsewhere in Philadelphia.

The great need for the work done by the Institute can, to some degree, be indicated by the numbers enrolled in the three types of work in which all three of the schools are engaged—the College of Applied Science, the Evening Courses, and the Extension Division. The Drexel Institute to-day is training five hundred students in the College of Applied Science, seventeen hundred students in the Evening Courses, and three hundred students in the Extension Division.

Numbers alone, however, do not give all the informa-



THE DREXEL INSTITUTE

tion needed. The type of student reached is of capital importance as indicating the community groups who most need the education for which the Institute was founded. Three types of students are enrolled in these three sectors of Institute work. The regular day students in the College of Applied Science are high school graduates who come for regular undergraduate work in the two- and four-year courses in the three schools. The students in the Evening Courses range from men taking comparatively elementary work in preparation for engineering courses to men with advanced degrees. All are enrolled in group courses. No course is shorter than two years, and coördinated courses of seven years in length may be taken. There are now 37 students enrolled in the seven-year course. The Extension students are mature men and women who have irregular hours to give to study—homemakers who desire knowledge of the arts and sciences which are at the foundation of the successful handling of home problems; men who are on night shifts. To these students the Institute opens its doors at any hour when there is a class room vacant and a teacher

free, from eight in the morning to ten-thirty at night.

In its search for the maximum capacity for service, the Institute has found many paths open, besides those already mentioned. Its hospitality is gladly extended to many bodies concerned with the advance of science and education. Its public concerts give much to the community at large, and it shares, in many ways, in the civic, scientific, and educational life of the time.

A sign in a little shop in the Rue de l'Opéra used to say, "Speak to anyone here—all are glad to see you and anyone can tell you anything you wish to know." And the fine spirit which prompted this sign is present within the walls of the Drexel Institute. There is nothing more significant of the eager interest of the whole community in the purposes and ideals of Mr. Drexel than the fact that any member of the faculty or student body can "tell you anything you wish to know" about the Institute. Mindful of their task of the development of citizenship and of the gaining of ability to do well a given life task, they are living the happy and useful lives that the Institute was founded to attain.

THE TEMPLE UNIVERSITY

WHAT IT IS, WHAT IT OFFERS TO STUDENTS, AND WHAT IT IS BECOMING

TEMPLE UNIVERSITY was founded to meet unsatisfied educational needs of the citizens of Pennsylvania. It was organized originally to furnish instruction to those who were not able to obtain an education in the regular educational institutions. It has always stood upon the education frontier looking for new educational opportunities and taking the most direct means of meeting them. It was the *first institution in Philadelphia* to establish an evening law school; to establish teachers' courses leading to degrees; to give a normal physical education course; to establish an undenominational theological school; to fit its hours of class attendance to the convenience of the people; to establish extra-mural classes supplying University work in

remote parts of the city; and it was the first to dignify evening instruction, requiring from evening classes the same standards and tests as those established for day students in this and other Universities.

Although founded to meet these specific needs, it was soon discovered that special afternoon and evening courses could not be maintained at the required standards without contact with regular day instruction. Day classes were, therefore, organized in the College of Liberal Arts and Sciences, in the Model High and Elementary Schools, and in the Teachers College. Other university departments have been added to the original college work, including the Medical Department, giving only a day course; the Dentistry Department, also giving only day



TEMPLE UNIVERSITY

classes; a Pharmacy Department, with classes meeting both day and evening; and a Law and a Theological Department, with classes meeting only in the evening.

With the large growth of the departments and student body of the institution there has been no diminution in the readiness on the part of the University to adapt itself to the needs of all persons who appreciate the value of general or technical instruction.

New classes are organized at any time of the day or evening in any subject or department of knowledge for which a distinct need is demonstrated and classes meet in that part of the city most convenient for students. Personal interest in and contact with the students upon the part of the faculty and administrative officials is a distinguishing feature in Temple University. Individual instruction is common in all classes. The whole attitude of the institution is that of practical community service—the willingness to meet ever-changing communal requirements.

The teaching force of the University is made up of able scholars who take personal interest in the welfare of their students. The exceptional earnestness of the student body adds strength and effectiveness to the teaching. Probably there is no university faculty in the country which works more harmoniously in accordance with the spirit of the institution than does the faculty of Temple University.

The College of Liberal Arts and Sciences has a regular four years' College course giving the cultural subjects leading to the degrees of Bachelor of Arts and Bachelor of Science. It also supplies technical courses in Chemistry and Engineering, leading to special degrees in these subjects. About one-half of the students in the College department are public school teachers taking advanced courses either for cultural values or as an aid in increasing their efficiency in the profession. The College, like all other departments of the University, is coeducational and furnishes an excellent course for all young women. It is a special convenience to those who wish to attend a college course without leaving the city of Philadelphia. For the present year there are 830 students enrolled in the College, an increase of about twenty per cent. over the number enrolled at the same time last year.

The Teachers' College was organized by the group-

ing together of several normal departments which had been founded much earlier in the history of the institution. These special normal departments have now been standardized. A uniform four years' high school course is required for admission. Uniform standards of class work and uniform requirements for graduation are enforced. The special normal courses give instruction to those preparing for teaching in elementary schools, high schools, kindergartens, and in the subjects of Commercial branches, Household Science

and Art, Physical Education, Manual Training, Music, and Nurses' Training. Beyond these special normal courses, students have the privilege of working for two additional years and obtaining the degree of Bachelor of Science in Education.

The Teachers' College is not only preparing instructors for the schools mentioned above, but is qualifying young men and young women to assume charge of recreation centers, state and municipal, as well as those organized as part of the common school system; to supervise school gardens; to direct classes in the handicrafts; it also prepares dietitians for hospitals; housekeepers for public institutions; heads of industrial establishments; mothers' assistants; visiting housekeepers, etc.

The Department of Business Education.—There are three forms of activity undertaken by

the Department of Business Education. One is the elementary course, including Stenography, Typewriting, and Book-keeping, for those persons who have had only the advantages of a grammar school education. Second, Business courses of College Grade, including work in preparation for the higher fields of business activity, for secretarial positions, and, in connection with the Teachers' College, for teaching positions in high school and commercial colleges. Third, special courses of a higher character, including the course leading to the Certified Public Accountants' examination; courses in Salesmanship, Advertising, Real Estate Law, Plan Reading, Estimating, Speed Practice, etc. This department enrolls about 1000 students, of whom one-fourth are in day classes. It has a strong and numerous body of Alumni actively engaged in the business world.

The College of Music was organized to meet the



DR. RUSSELL CONWELL
PRESIDENT
TEMPLE UNIVERSITY

evident need among musicians of Philadelphia for training along advanced theoretical and practical lines. The course for the Bachelor's degree comprises two years of the usual cultural College course, added to which are two years of work in theoretical and practical music. The concert master of the Philadelphia Orchestra, Thaddeus Rich, Mus. Doc., is dean of the College. The instructors in the several classes are masters of their subjects. The curriculum was recently reorganized along the lines of the strongest college courses in music in America.

The Law School was founded to prepare persons thoroughly for admission to the practice of law, including admission to the Bar, by evening instruction and by office experience in the daytime. Graduates of the School have been exceptionally successful in the passing of State Board examinations with the highest honors in Pennsylvania, New Jersey, and other states. Nearly all the students earn their living while pursuing the law course. Many of the graduates are now occupying positions of special prominence in the legal profession and on the judicial bench. The course extends through four years, classes meeting four evenings a week from seven to ten o'clock. Not only in the high character of instruction, but also in the actual number of lecture and quiz hours, this course is the equal of any day course in the country.

The Dental Department of Temple University is the Philadelphia Dental College, one of the oldest and best dental institutions in America. The affiliation of Temple University with the Dental College brought into the University a well-organized dental course, an experienced faculty, a strong body of students, and a large and loyal Alumni.

The Medical Department of Temple University was founded in 1901 with the purpose of furnishing a course of partly evening and partly day instruction preparatory to the practice of medicine. The early evening classes were remarkably successful in the character of the students obtained and in the quality of work performed. Under recommendations of the American Medical Association, however, the evening school was transferred to a day course organized upon the same plan of work which had been so successful in the evening courses. This plan embraces the study of several aspects of a given part of the human body at one time. Thus, the professor in physiology correlates his work with the professor of anatomy and these with the instructors in pathology and neurology and other departments. The brain, the heart, the digestive organs, are studied at one time from all the several points of view. This correlation, which proved so successful in the evening courses, has led to the development of a strong day class and the students have a special and wide opportunity for constant bedside observation.

The Medical School is particularly well situated also in the fact that it has access to two very active

hospitals—the Garretson, immediately adjoining the Medical College, constantly treats cases from the central mill district of Philadelphia, while the large Samaritan Hospital reaches a more general field and is situated in beautiful grounds in the northern part of the city. The proportion of teaching cases per student is higher than in any other medical school in Pennsylvania.

The Pharmacy Department was founded in 1901 as an evening school. The demand for day instruction or for part day and part evening instruction made it desirable to organize day classes as well. At present, classes meet both day and evening. This department, like all other departments of the University, is co-educational and has been successful in preparing many young women, and a large number of young men, for the profession. It has turned out many hospital pharmacists and scientific specialists.

The Theological Department is unique in that it is interdenominational. It is conducted entirely in the evenings, and its students earn and pay their own way. The professors of strictly theological subjects are successful preachers and pastors. Such men give a broad outlook from their actual experience and from close association with advanced Church methods.

The department requires a college degree from the Temple University or from some institution of equal rank for entrance upon the course leading to the degree of Bachelor of Divinity. But it offers special courses not leading to the degree. A successful special course has been that in the study of the English Bible, designed for Sunday-school teachers and other special students, which meets two evenings a week. The department has also organized a strong correspondence course, giving the degree of S.T.D. These courses are the only ones of a correspondence character given in the whole institution. They have been successful in helping ministers and pastors who are located in other states and countries and often far from regular educational institutions. The persons receiving the degrees must be fully deserving of the recognition to be given them.

Nurses' Training Courses and the Companion Nurses' Course are maintained at the Samaritan Hospital and at the Garretson Hospital of Temple University. The idea of these courses is not simply to train young women for the simpler forms of nursing, but also to give them a useful education for life, and to train them for administrative positions such as superintendents of hospitals, directresses of training schools, and as companion nurses. The candidates for diplomas are required to attend all lectures upon the social and intellectual duties of a nurse.

Industrial Courses.—In pursuance of its policy to supply whatsoever educational needs are brought to its attention, Temple University has from time to time founded a number of short-term special courses, largely of an industrial character. Some of these are for men

alone, others for women, and others open to both. Among the industrial courses for men may be mentioned those in Chemistry; Mechanical, Architectural, and Freehand Drawing and Designing; courses in Surveying, Sheet Metal Work, Strength of Materials, Plan Reading and Estimating, Hydraulics, Building Construction, Manual Training.

For women, courses are offered in Dressmaking, Millinery, Cookery, Household Economics, Social Service Work, Basketry, Hand Loom Weaving, Tooled Leather Work, Book Binding, Chair Caning and Rushing, etc.

The University High School, originally holding only evening sessions, comprises a well-organized day school, as well as largely attended evening courses. The courses are maintained for three purposes: First, to prepare persons, either in the day or evening, for entrance to colleges and professional schools or for the passing of preliminary State examinations in high school subjects. Second, to furnish the general cultural education given in the best High School courses. Third, to furnish a Practice School in which the students in the Teachers' College can gain experience in high school teaching. In only a very few institutions in the entire country is there given such an

opportunity for practice teaching in the high school grades.

Model Schools of kindergarten and of elementary grades for children are also maintained as parts of the Teachers' College work. All candidates for graduation must have shown their ability to teach by actual work in the class rooms. The Elementary Schools are maintained as a basis for this teachers' training work. They have also been able to test educational values and have proved that the work of the elementary schools can be very readily covered in seven years as against the eight usually required in public schools.

Temple University is now recognized as the laboratory in which are tested out the educational needs of the community. These needs vary from year to year. It is impossible for more rigidly organized institutions to adjust themselves quickly to these ever-changing community conditions. Temple University organizes a course in any subject for which a sufficient number of students apply. Record is kept of all applications for any subject of instruction and a class is formed as soon as the demand seems to warrant it. By steadily adhering to this plan, the University has met definite educational needs in a practical way, and has assisted many thousands of students.

HAVERFORD COLLEGE

ITS PURPOSES AND METHODS

HAVERFORD aims to fulfil the function of a small college of the best sort. Its endeavor is to give a general education along broad lines, bridging the chasm between the absolute elective system of many universities and the closely outlined and rigidly systematized courses of many smaller institutions.

The president, faculty, and trustees have held that there is increasing room in the United States for cultural education, modified to a sane degree by certain of the necessary elements in the practical world of to-day. Such was the purpose of its founders in 1830, and as such it is maintained now.

Haverfordians are united in the opinion expressed recently by one of the most prominent manufacturers of

steel in the United States: "Send me men who are fully acquainted with languages, history, higher mathematics, and general science—men who write good letters, and speak and read good English. I myself will see that they are made into technical experts." President Sharpless, at a recent meeting of the Maryland Alumni, stated in a few words the aim of Haverford: "Haverford aims to equip men who know what to do with their leisure and who will at the same time take a serious interest in the affairs of the world."

Haverford, therefore, makes no effort to set itself up as a rival to the technical or the professional school; it aims to fit a man for life by a liberal training under ideal conditions, whether his ambition suggests business, technical, or professional life.

There are various practical matters which Haverford emphasizes in endeavoring to attain this ideal. In the first place, the college is situated ten miles from a large city, Philadelphia, with a campus of 70 acres and a total park and farm ground of 226 acres, laid out in 1837 by an English gardener who was familiar with the country estates of England. The value of the equipment of the college and its real estate is estimated at one and one-half millions of dollars. The interest-bearing funds, exclusive of real estate and buildings, amount to two and one-half millions of dollars. Thus these two features—an



DR. ISAAC SHARPLESS
PRESIDENT
HAVERFORD COLLEGE

adequate endowment and splendid natural surroundings—form an ideal basis on which to build.

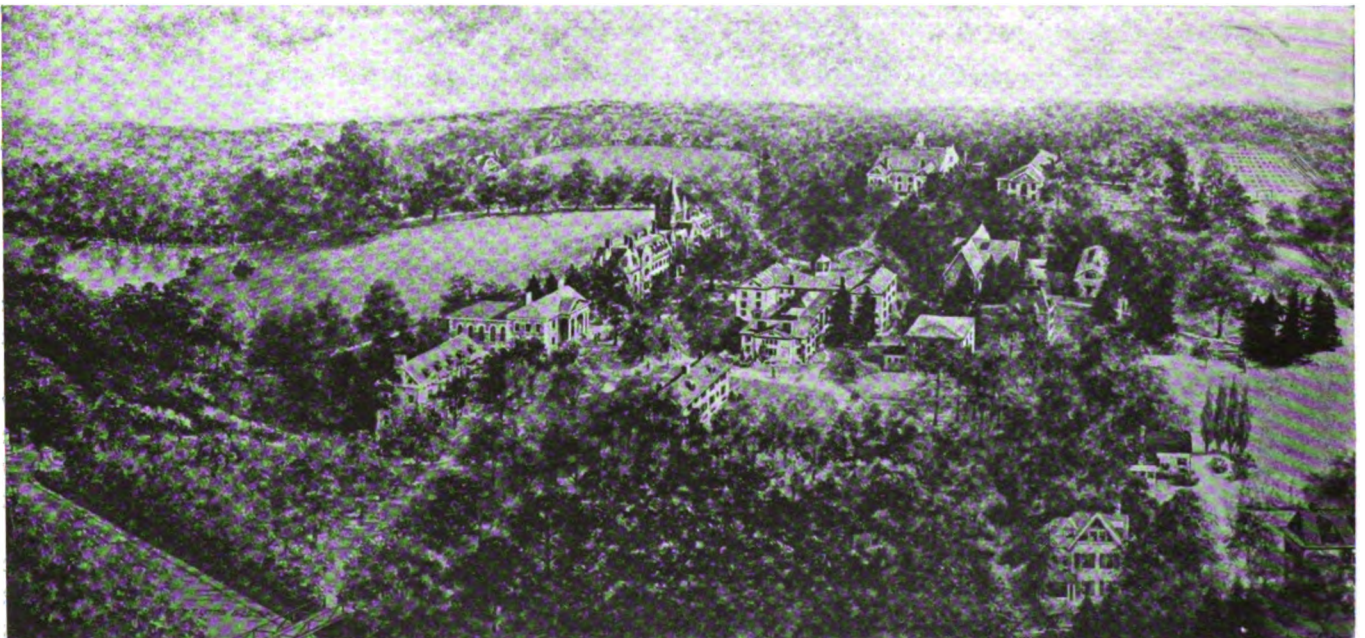
Another important feature of Haverford is the large proportion of faculty members to students. The student-body totals 195 (a slight increase over any previous year) and the faculty numbers 24, thus making a proportion of eight students to each member of the faculty. Together with these facilities of intimate contact between students and faculty may be taken the large endowment of the college library, now in possession of 75,000 volumes and an annual income of over \$5000. Voluntary reading and a sort of preceptorial teaching system are two especially emphasized points in the Haverford curriculum.

In the life of the students themselves one notices several details which do away both with the ultra-specialization which is necessary in the large university and with the athletic eligibility problems rampant all over the United States. Offsetting the former difficulty, Haverford prides itself on the fact that students are developed in an all-round way. In an institution of 195 men there are two college papers, a dramatic club which makes six trips during the spring vacation to cities along the Atlantic coast, a glee and mandolin club, and civics, science, and classical societies—all these in addition to seven athletic teams at various seasons of the year, Phi Beta Kappa organization, an honor system, and a students' council which confers at intervals with the dean and affords what is practically self-government to the students. Athletics are supervised directly by the college authorities,

and every team coach is directly in the pay of the institution and under the supervision of the president and faculty athletic committee. The physical director, also a practising physician in Philadelphia, emphasizes athletics in such a way as to avoid clashing and to permit all-round physical efficiency.

There are fifteen scholarships for each class, which together with an employment bureau both for undergraduates and alumni, conducted by the dean, enable deserving fellows to work their way through college. In order to bring about the desired aristocracy of intellect hand in hand with the democracy of college student life, the faculty awards the first four of these scholarships in each class on class standing alone, irrespective of financial means. Men of the amplest means are likely to be holding Corporation Scholarships, as these are called, along with men to whom every cent is vital.

A few facts about the alumni of Haverford College will prove that the statements made above are truthfully conservative. *Who's Who* for 1916-'17 includes 58 living Haverford alumni out of a total of 1500. Haverford has had six Rhodes scholars at Oxford, a Nobel science prize winner, men of distinction in the medical world to a remarkable degree, prominent scholars, architects, art critics, philanthropists, and leaders in business. Through its branch alumni associations in New York, Baltimore, Boston, Chicago, and California, all working in harmony with the central Philadelphia society, there is complete unity in the carrying out of the Haverford ideal.



BIRD'S-EYE VIEW OF HAVERFORD COLLEGE
LOOKING SOUTH

EDUCATIONAL
VILLANOVA COLLEGE

VILLANOVA College was founded in 1842. The aim of her founders was to impart a thorough liberal education such as might develop a broad-minded personality, a high appreciation of our complex social relations. They felt that a trained mind endowed



REV. E. G. DOHAN
PRESIDENT, VILLANOVA COLLEGE

with an alert and critical judgment, an ability to understand facts in their principles and in their bearings and relations to other facts, was the most desirable foundation for a life of usefulness in the business, technical, or professional walks of life. They realized, too, that education, to be worthy of the name, should not be one-sided, should not consist in purely mental development, but should reach the will as well; that the mind

and the heart should be strengthened in the understanding and practice of right principles of conduct; in other words, that the training of moral character should not be neglected. Hence they aimed to furnish a moral and religious atmosphere favorable to the development of a sense of responsibility and the upbuilding of character. Consequently, in the methods of discipline and in the general teaching, they laid due emphasis upon religious and moral agencies. While Villanova makes no distinction of creed in her requirements for admission, she exists primarily for the education of Catholic youth and follows Catholic principles in the development of her educational policy.

In 1905, Villanova, in response to the increased de-

mand for men trained in the practical work of applied science, opened a School of Technology and offered courses in Civil, Electrical, and Mechanical Engineering. The twelve years which have elapsed since that date have proved that she did not overestimate her ability to develop trained, efficient technical men able to take their place among the leaders of industry. Her graduates have proved their excellence in all competitive examinations in which they have entered, and to-day they are found in the employ of the government, the large railroads and large industrial establishments of the country.

In her technical course Villanova lays great emphasis on the value of practical work in the shop and laboratories as a means of understanding in their application the theories underlying applied science. Thesis work of a practical character is exacted as a condition for graduation. In this way much of the equipment in the electrical laboratories has been constructed by the students themselves; likewise the station of wireless telegraphy, which plays an important part in the Engineering courses. Being located twelve miles from Philadelphia's center, away from the distraction of the city life, in the midst of a large, undulating country along the main lines of the Pennsylvania and Western Railroads, the technical students of Villanova possess many advantages for topographical and field work and for the practical study of railroading, while the excellence of the transportation facilities gives them easy access to the industries of Philadelphia, to which frequent visits are made.

The environment of Villanova is favorable to the cultivation of habits of study. Removed from the distractions of city life, the students have every inducement to apply themselves to their tasks. The splendid natural beauty of the spacious grounds (comprising almost 200 acres), enhanced by the skill of the landscape gardener, is a constant source of admiration to all who travel along the Main Line.

Being a small college, its students necessarily come in



VILLANOVA COLLEGE
ENGINEERS' CLUB OF PHILADELPHIA

intimate contact with the instructors and thus derive the benefit of individual attention. Those relations of close intimacy between instructor and student are carried outside of the class-room, and the students are encouraged to confer with the instructors, to seek them out for advice and counsel. Villanova insists that the instructors have a personal interest in the individual members of their classes, and the size of classes is always so regulated as to permit the accomplishment of this purpose.

An Engineering Society, to which all technical students belong, assists materially in developing the students along practical lines. Papers on practical topics, illustrated by drawings, slides, etc., are regularly read and discussed. Visits are made to large shops, shipyards, etc., and reports are prepared which form the basis of fruitful discussions.

The danger of technical education being too one-sided is offset by the fact that opportunity to pursue courses in languages and cultural subjects is readily obtained through enrolment in classes of the general course.

The student life of the college is such as to appeal to the active growing youth. Athletics are encouraged in a sane and healthful way. Various societies, dramatic, literary, etc., afford opportunities for development of ability along these lines. The societies are in no sense exclusive: strict democracy is the keynote of all undergraduate associations. The discipline is based upon a modified honor



ELECTRICAL LABORATORY, VILLANOVA COLLEGE

system. The rules are reasonable and are calculated to develop a habit of obedience, together with a sturdy manliness and a spirit of responsibility.

While the property and equipment of Villanova are very valuable, being worth more than one million dollars, she has but few scholarships, nor can she boast of large endowments of money. On the other hand, she has not large expenses for the salary of officers and instructors, since all of the former and most of the latter, being members of the Augustinian Order, to whom the college belongs, receive no recompenses in the form of salaries, devoting themselves wholeheartedly and out of a motive of religion to the education of youth as their chosen lifework.

THE WILLIAMSON SCHOOL OF MECHANICAL TRADES

THIS school was founded by Isaiah V. Williamson for the purpose of giving poor and deserving boys a good English education, for training them in the habits of morality, economy, and industry, and for teaching them trades.

It is located on the Central Division of the Philadelphia, Baltimore and Washington Railroad (Pennsylvania Railroad), about sixteen miles from Broad Street Station, Philadelphia. Its railroad station, as well as post-office address, is Williamson School, Delaware County, Pa. It can also be reached by the Media Short Line cars from the Sixty-ninth Street Terminal, Philadelphia.

Admission of scholars is made in April of each year, none being received who are under sixteen or over eighteen years of age; but applications for scholarship may be made at any time for boys aged fifteen years and upward, and who will not be over eighteen years old at the next admission period. Blank forms for the purpose can be had by addressing the school, or the Philadelphia office, 119 South Fourth Street.

The applications for admission exceed in number the capacity of the school, and registration and examination do not therefore necessarily mean admission. Candidates are required to pass scholastic, moral, and physical examinations, after which a selection is made of the number the school can accommodate, under the following conditions:

Other things being equal, preference in admission will be made in the following order:

To those born in the city of Philadelphia.

To those born in Bucks County, Pennsylvania.

To those born in Montgomery and Delaware Counties, Pennsylvania.

To those born elsewhere in Pennsylvania.

To those born in New Jersey.

To those born elsewhere in the United States.

Only natives of the United States are eligible for admission, and no one will be accepted who is not able-bodied, intelligent, healthy, and possessed of natural aptitude and liking for mechanical or agricultural work. Candidates, to be successful, must also be of good moral character and sufficiently educated to readily enter on the school work.

Special attention is called to the fact that the school is distinctly vocational and only for pupils who intend to follow for a livelihood the trades there taught them, and no others will be admitted.

The scholastic examinations are held about four months prior to the date of admission, and include reading, writing, spelling, arithmetic (as far as fractions, weights and measures, and interest), geography, United States history, composition, and language. Applicants are recommended to prepare themselves for this examination.

After a moderate preliminary trial all who prove satisfactory are bound as indentured apprentices to the trustees for the term of three years from their entrance, with the provision that the indenture may be cancelled at any time by the trustees for the scholar's incompetency or bad conduct, or if for any other reasons the trustees think him undesirable for future and continued support and education. By the indenture the scholars will be obligated to conform to all regulations and restrictions prescribed by the trustees or their representatives, and all right or claim to control them during the period they remain at the school will be vested in the trustees.

The trades taught are as follows, the selection being made by the trustees:

Agriculture, including a practical and scientific course in dairying, horticulture, general farming, etc.

Carpentering.

Bricklaying, including range, furnace, and boiler setting, etc.

Machine trade in all its usual details.

Operating engineering, including care of steam and electrical appliances, steam fitting, etc.

Pattern making.

The shops are well equipped in all respects for trade teaching. The operating engineers receive their practical training in the steam and electrical power plant, which provides heat, light, and power for the establishment.

Each scholar takes but one of the trades named, and his instruction in mechanical and freehand drawing tends in the general direction of his particular trade. The



HARRY S. BITTING
PRESIDENT

courses are systematic and thorough, and are based on instructional methods.

The branches taught in the academic department are reading, grammar, writing, arithmetic, algebra, trigonometry, physical and political geography, history, physical science, English literature, physiology and hygiene, civil government, chemistry, elementary vocal music, theory of the steam engine, strength of materials, and building construction.

The school and shops are in session eight hours daily on five days of the week and three hours on Saturday, each scholar spending about four hours in the academic work and four hours in the manual work daily the first

year, the proportion spent in manual work gradually increasing towards the close of the apprenticeship.

The school term continues the entire year, but those pupils who merit it are given four weeks' vacation in summer and a short time at Easter, Fourth of July, Thanksgiving, and Christmas.

Scholars are required to bring with them a plain outfit of clothing, but while at school no charge is made for boarding, clothing, or instruction, the benefits of the institution being free.

The pupils may receive visitors on Saturday afternoons, application being first made at the school office.

The domestic life of the school conforms, as far as practicable, to good family government. To that end the scholars are divided into families of twenty-four, each having its matron and its own distinct home or cottage, cared for by its occupants. The homes contain no kitchens, dining-rooms, or laundries, these being located in other buildings.



PANORAMIC VIEW OF WILLIAMSON SCHOOL

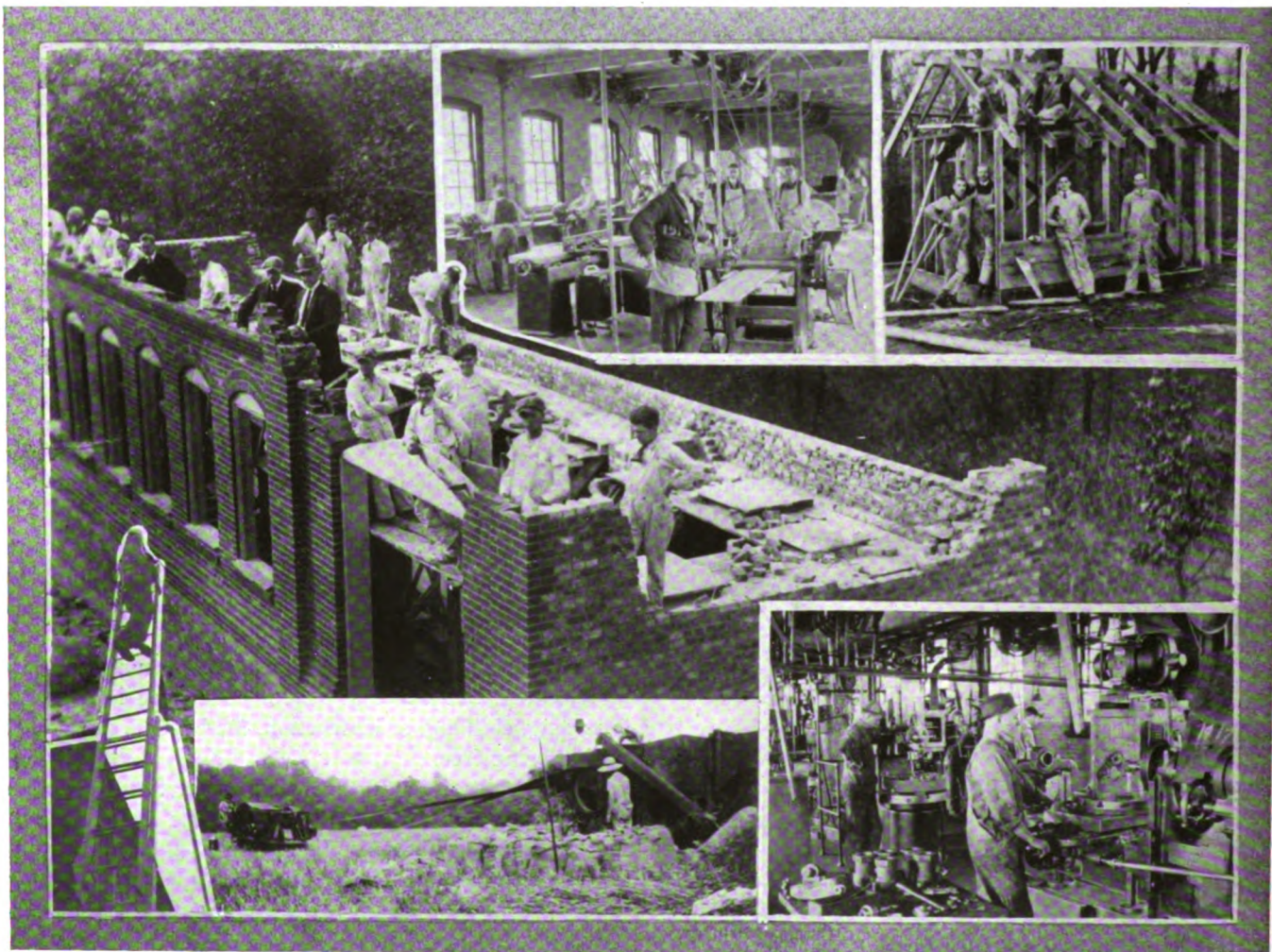
ENGINEERS' CLUB OF PHILADELPHIA

The trustees deem it to be quite as essential to have the pupils become good men as good workmen, and special attention is given to their moral training. The school is non-sectarian, but each pupil, immediately after admission, is required to designate the religious denomination of his choice, and thereafter attend its service regularly at its place of worship in the neighborhood.

The total enrolment at the present time is 230:

40 Agriculturists	31 Engineers
40 Bricklayers	43 Machinists
43 Carpenters	33 Patternmakers
Total number of instructors—mechanical 7	
Total number of assistant instructors—mechanical 5	
Total number of academic teachers 7	

The diploma sets forth the fact that the young man has completed a three-year apprenticeship as outlined in the bulletins.



CARPENTERS AND BRICKLAYERS AT WORK ON CONSTRUCTION OPERATIONS, PATTERNMAKERS AND MACHINISTS IN SHOP AND AGRICULTURISTS AT WORK IN THE FIELD

EXTRACT OF ADDRESS BY HARRY S. BITTING, PRESIDENT WILLIAMSON FREE SCHOOL OF MECHANICAL TRADES

SUBJECT: "ADMISSION REQUIREMENTS, PLACING STUDENTS, ETC."

IF a school proposes to graduate journeymen mechanics, pupils must be sufficiently matured physically and mentally on graduation to do men's work. They must have the appearance as well as the quality of manhood to merit a man's pay. No matter what plan may be adopted for teaching trades, this is the most important consideration and must not be overlooked. Candidates should be at least sixteen years of age and sound physically. Academically they should readily pass a high-school entrance examination. Their general fitness and desirability should be ascertained from references and by personal interviews. No one should be accepted as a pupil who

has not a positive intention of beginning his business career as a workman at the trade which the school will teach him. That this is practicable is shown by the fact that as high as 98 per cent. of the members of a class of our school have, on graduation, immediately started as journeymen at the trades taught them.

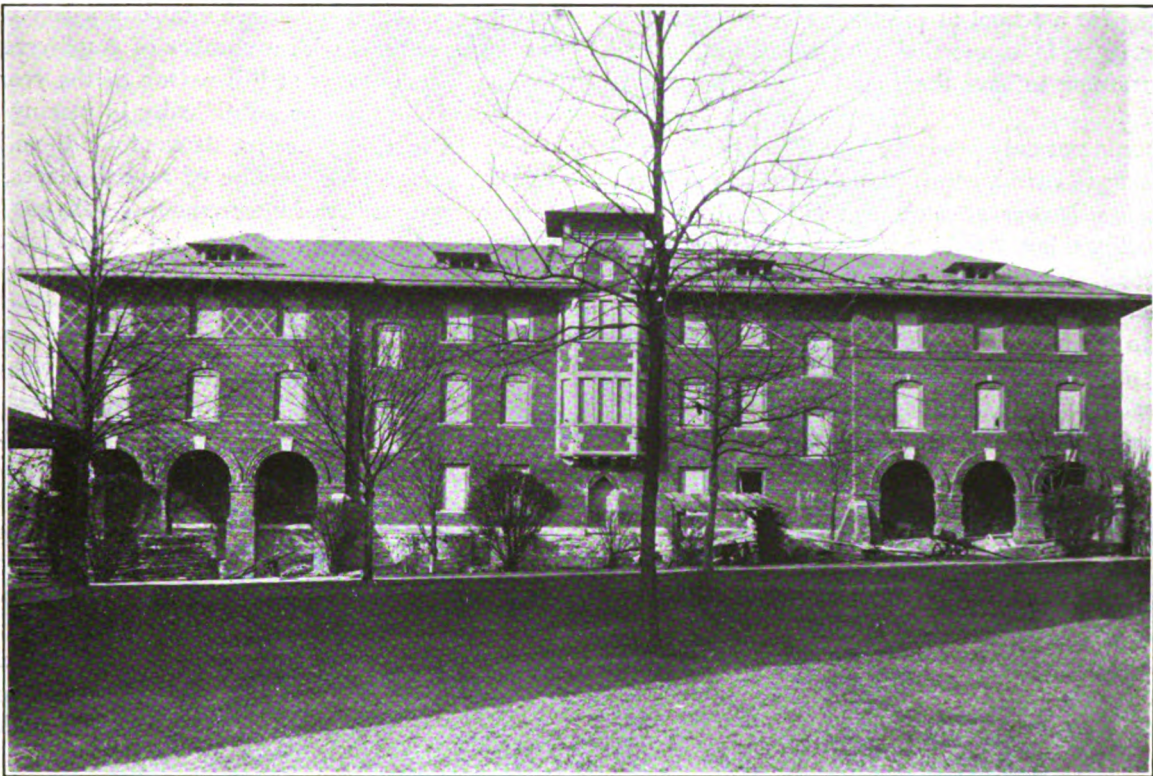
Generally the average boy can succeed at any one of several trades. A long experience in the matter indicates that the trade should be fixed at the beginning of the school course, otherwise valuable time is lost in experimenting, and uncertainty and disagreement on the subject are quite likely to follow.

The courses must be of sufficient length to include well-graded and thorough instruction in the practice as well as the theory of trade work, with proper collateral academic training, especially in mathematics and mechanical drawing. As one mechanical process is mastered it should at once be succeeded by another. This advancement and the knowledge that the sole object of the instruction is to benefit the pupils adds greatly to their interest in their work.

Time must be given to enable the pupils to properly absorb or assimilate what is taught them, and in most trades three years is not too long for this purpose. A

dominant tone of the school must be the shop instruction, the academic being auxiliary to it. Trades can be taught best in schools especially devoted to that work rather than in those in which they are merely adjuncts to general education.

The earlier and simpler trade exercises must be combined in more complex problems toward the end of the course. The school day should be eight hours long on five days of the week and about three hours on Saturday, divided equally for a while between trade and academic studies. During the last six months of the apprenticeship the whole day should be spent on mechanical exercises.



DORMITORY DWELLING ERECTED BY THE STUDENTS

certain moderate time should be devoted to cultural studies.

Returning to the trade exercises, we must insist that they be very comprehensive, qualifying the apprentices to cope readily with the practices and problems involved in commercial work. This is entirely practicable, and it is pleasing to note the comparative ease with which young men thus trained can apply their knowledge and skill to the varying conditions of the business world.

The mechanical drawing, after the elementary exercises, must directly pertain to the specific trades.

Throughout the entire course the leading feature of the training must be the mechanical, while the academic instruction, especially in mathematics and drawing, must have a well-defined connection with trade work. The

This adds to the ease of the transition to commercial fields. There is no difficulty in maintaining satisfactory continuing interest during days of the length indicated.

The mechanical teachers must be masters of their respective trades, of good general education, well versed in mechanical drawing and mathematics, and capable of readily imparting their skill and knowledge to their pupils. Such instructors are scarce, but they can be had, and the supply will increase as trade schools multiply. It will not answer to have school men with a limited practical knowledge of trades as mechanical teachers.

The value of material must be constantly kept in the pupil's thought, and estimating costs should be a part of the instruction. Time cards and a bonus system should be used. The equipment must be of excellent quality and of

such variety and capacity as to familiarize the pupils with the appliances they are to use in the world of business. The exercises should have natural dimensions and not be mere playthings. The work must be instructional and for the pupils' benefit. The instructional methods of a properly-managed school are much more efficient than the commercial usages of shops. In this connection, as before stated, it must be borne in mind that it is necessary for a school to give its apprentices sufficient shop experience in connection with the theoretical and technical training to have them readily enter on commercial work.

We should not only prepare trade school graduates by their training to earn a comfortable living and a surplus, and to scan whatever advancement may lie in the path of their callings, but should make it possible for them to become good citizens, capable of rendering their fair share of service in the higher activities of life, a blessing not only to themselves, but to their fellow-creatures.

Professor Davenport, of the University of Illinois, has well said: "There is no higher duty resting upon all of us than to see to it that no individual shall be compelled to choose between an education without a vocation, and a vocation without an education. I would have it so that the occupation of an American citizen may not be known by his dress, his manner, his speech, or his prejudices."

Placing Students, or, as I would express it, Placing Product of the School.

It might not be out of place for me at this time to refer to the experience of the school with which I am connected. In the early history of our school employers hesitated to take our graduates at journeymen's rates of compensation, and I might add, in those days we admitted the boys at an earlier age than we do at pres-



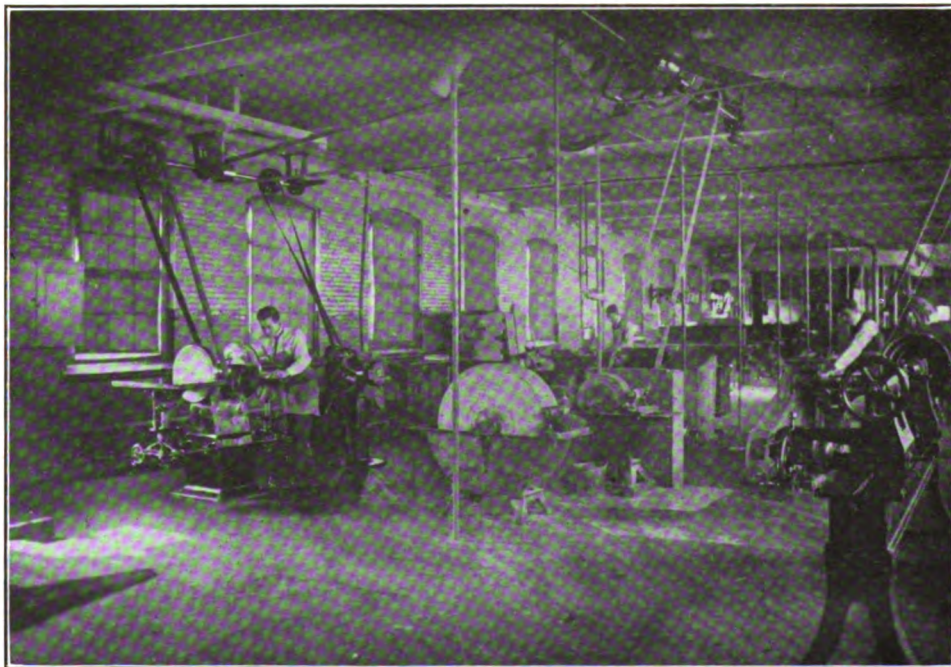
STUDENTS REPLACING WOODEN LIGHT POLES WITH CONCRETE ONES

ent and graduated them at an average age of eighteen. Later the minimum age of admission was changed to sixteen, the average age of admission being seventeen and that of graduation twenty, and as the reputation of the school grew employers very readily took on our men at fair rates of compensation. We in most cases recommended the men and suggested that they be employed on probation, and the rate of compensation fixed at the expiration of

this period. By this plan we established very satisfactory business relations with a number of employers, who now regularly come to us at this season of the year for men. We now have little or no difficulty in placing our graduates. In fact, at times the demand for them is so great that a number have a choice of several places, and quite often every member of the graduating class has had one or more opportunities offered him before leaving the school. We are greatly helped in this detail of our work by our own graduates, with whom we keep in pretty close contact. Prior to graduation we urge the men to keep us posted of their progress and about six months after graduation we send a personal request to them for information concerning their position, progress, etc. The response to these letters has been extremely gratifying and has brought about a relation which has been wonderfully helpful. If opportunities for mechanics appear in the community in which our graduates are located, they write us to that effect, and if any of our men need employment of the kind offered, we immediately notify them. A great number of our graduates are now employers, and at this

season write us for the pick of the class which graduates in March.

The graduates of our last class, on leaving the school, were scattered from Chicago to Tampa, Fla. Between these points there are dozens of employers who regularly apply to us in the spring, and frequently through the year write for additional help.



PATTERNMAKERS AT WORK

SWARTHMORE COLLEGE AND ITS ENGINEERING DEPARTMENT

SWARTHMORE COLLEGE was founded in 1864 through the efforts of members of the Religious Society of Friends. The intention of its founders was to make the promotion of Christian character the first consideration, and to provide opportunities for liberal culture while maintaining a high standard of scholarship. With this idea in mind, two distinctive features of the college were decided upon: First, it should be a small college; and, second, it should be of the first rank. The managers therefore determined that the enrolment should never exceed five hundred students. It was their belief that the close relationship between professor and student which is such a valuable asset to the small college is in danger of being lost beyond this number.

The attainment of first rank has been endorsed by the most authoritative experts in higher education in this country. In 1912, Dr. K. C. Babcock, representing the United States Bureau of Education, after a thorough investigation of the college, stated: "By way of summary, I am glad to say that I am convinced that the efficiency and spirit of Swarthmore College are such as to entitle it to rank with the best colleges in the country."

The Carnegie Foundation for the Advancement of Teaching, after a similar investigation, placed Swarthmore on its list of preferred colleges and extended the benefits of its Retiring Fund to its instructors. The General Education Board founded by John D. Rockefeller has on two occasions placed its seal of approval upon the educational standard of Swarthmore College by appropriating sums of money to the general endowment of the institution. In 1911 the Board appropriated \$75,000 for this purpose, and during the present year an additional \$125,000 has been added.

Credit for undergraduate work done at Swarthmore College is granted year for year at the leading universities of the country. Graduates of Swarthmore have secured

their Master's degree for one year's work or their Doctor's degree for three years' work in the following institutions: Harvard, Cornell, Columbia, University of Pennsylvania, University of Wisconsin, and University of Chicago.

National honor societies, such as Phi Beta Kappa, Delta Sigma Rho, and Sigma Tau, as well as scholarships and fellowships, act as constant incentives in maintaining high scholastic standards. To these must also be added a friendly rivalry among the fraternities to occupy first place in scholarship.

Swarthmore is coeducational. Its ideal in regard to the number of students is 250 men and 250 women. This is in harmony with the traditions of Friends, and materially promotes the ideals of the college. It also enables the college to provide college life in a home setting; and provides an atmosphere in which manly and womanly character may develop naturally and completely. The intercourse of the students under the care of the Dean of Women and her assistants aims to make it a means of social culture. Visitors often compare the dining-rooms in men's dormitories, club-houses, or fraternity houses with the homelike atmosphere of the dining-rooms at Swarthmore, where young



DR. JOSEPH SWAIN
PRESIDENT
SWARTHMORE COLLEGE

men and young women sit at the same table.

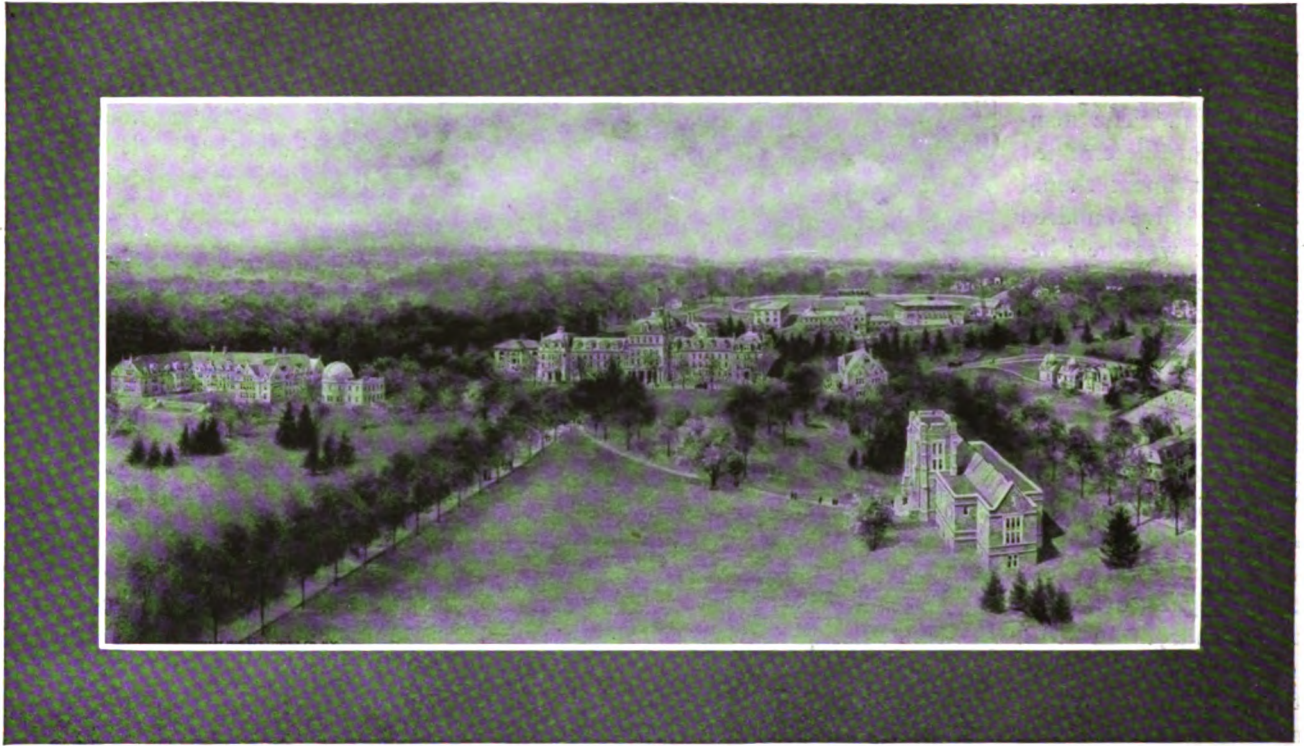
Traveling representatives of the Y. M. C. A. and similar organizations seldom fail to comment upon the high moral standards and the clean moral lives led by the men students of Swarthmore. Some of the problems relating to the moral life of students which often perplex college authorities have no existence at Swarthmore. Athletics are not without their influence in this regard. It is one of the ideals of the college that at four-thirty all students shall be in the gymnasium or on the athletic fields. Practically all male students try for some athletic team. New athletic fields have just been completed, and the

Sharpless swimming pools have recently been added.

Religious, literary, scientific, social, musical, and dramatic organizations are maintained by the students. The students also maintain an honor system which deals with any case of dishonesty arising in connection with class-room work. For the purpose of regulating student conduct, student government has been developed to the point of making the students practically self-governing. Many persons consider this the students' most important

student for the most effective service to humanity and the greatest personal happiness.

The wisdom of maintaining such a policy while other schools were feverishly developing courses of extreme specialization is shown by two facts: First, the success of its graduates. Call the roll of eminent engineers in the civil, electrical, mechanical, mining, chemical fields, in industry and in business, and in each you will find Swarthmore men. Second, there is at present a demand from all



BIRD'S-EYE VIEW OF SWARTHMORE COLLEGE

achievement, and believe that its effect in developing those traits of character that make for good citizenship cannot be overestimated.

With the general ideals of the college as a background, those of the Engineering Department could almost be anticipated. Certainly one who is familiar with the present trend in technical education, of confining the student's work in the regular four-year course to fundamentals, and of broadening the curriculum with cultural studies, would expect to find Swarthmore in perfect harmony with such ideals.

An interesting fact in regard to the Engineering Department is that from its establishment its fixed policy has been to maintain a proper balance between technical and liberal studies; to regard a thorough drill in the fundamental sciences of engineering as of more importance than ultra-specialization. The shops and laboratories are well equipped, but specialization has been permitted only to the point of quickening the student's interest, of increasing his ultimate achievement, and of giving him an immediate earning capacity upon graduation. This plan, together with a proper consideration of the human side of the profession, would, it has been believed, prepare the

authoritative sources for a more thorough training in the fundamental sciences of engineering, and a general broadening of the engineering courses, so as to include some of the so-called cultural studies.

A recent investigation proved that the Engineering Department of Swarthmore College is maintaining its lead in hours of time devoted by its students to the fundamental sciences, and in the ratio of non-technical to technical hours.

Other features of this department which prove of interest to visitors are: classes in public speaking where students talk shop to non-technical students (See *Engineering Record*, August 12, 1916); discussion classes where students meet professors to discuss informally problems of interest to the student; a suggestion system by which any student in the department may make suggestions to be considered by a committee of students appointed by the members of the Engineers' Club, the head of the Engineering Department, and the Director of Shops.

The Engineers' Club, of the college, which was organized by the students, confines its speakers to its own members. It elects a president, but permits him to

preside at only one or two meetings, designating for the other meetings a "presiding officer." This office rotates among the Senior members, and was created with a view of giving them the experience of presiding.

In order to make the personal relations of student and instructor closer than is possible under the class adviser system, the students are divided into small groups and placed under the direction of a member of the teaching force, who is known as their departmental adviser. He keeps in close touch with the students' work, extends a helping hand when needed, and notifies the class adviser of any matter that may require his attention.

For the purpose of supplementing the class records kept in the Dean's office, the department keeps "personalities" cards and "extra-curriculum" activity cards. The first card is for the purpose of recording any personal characteristic that may be especially noticeable in the student. If such a characteristic is considered detrimental

to the student's welfare, or a handicap, the matter is made the subject of an interview with his class adviser. It is merely an effort to help the student realize his greatest possibilities, and is accepted in that spirit. During the past year Dr. Blackford, the employment expert, also devoted several days to this work among the Seniors. The "extra-curriculum" activity card takes note of every activity that the student has, or is engaged in outside of the class-room, and of all honors, if any, he has attained. This information is often very valuable to the class adviser, who makes every effort to help the student find himself.

The course itself has been so developed that if the student finds at any time up to the beginning of the Junior year the work is more difficult than he cares to attempt, or that he is not fitted for or interested in Engineering, he can be transferred to practically any other department in the college without loss of time.

GIRARD COLLEGE

GIRARD COLLEGE (founded under the will of Stephen Girard) is an institution for the rearing and educating of orphan boys. Girard was the richest man in America at the time of his death, and left his residuary estate, estimated at about six millions

of dollars, to establish an institution for the care of "poor, white, male orphan boys." Later, by decision of the Supreme Court, an orphan, under the terms of the will, was held to be a boy who had lost his father.

The Founder carefully provided for the conditions of admission and for many other details in the management of the College. Boys are admitted between six and ten years of age, and may continue in the College until from

The College is a home as well as a school, but it comes nearer the boarding-school ideal than the ideal of an orphanage. Although every boy who comes to the College is indentured to the City of Philadelphia, Trustee, and the College rears and cares for him in every particular, monthly reports are sent to the mother or the nearest known relative of the boy, and constant communication is kept up with the home or the nearest known friend.

The present normal capacity of the College is 1520 pupils, and the boys to this number are kept in the College nearly all the time. The waiting list of boys to be admitted has been, in recent years, from 500 to 800, and a large number of those on the list from the state of Pennsylvania, outside of Philadelphia, are not reached, they becoming ten years of age in advance of there being a vacancy for them.

EQUIPMENT AND ENDOWMENT

The Main Building of the College is an imposing Greek structure. In addition to the Main Building, there are some twenty other buildings for the purposes of the institution, among them being a chapel, school buildings, dormitories, dining hall, an infirmary, and mechanical school building. Forty acres are enclosed for the use of the College by a substantial stone wall, ten feet high. Heat, light, and power for all the buildings are furnished from a central plant, situated at the western end of the grounds. The grounds are lighted by seven steel towers, one hundred and twenty feet high, each carrying six arc lights. The estimated value of the plant of Girard College is about six millions of dollars. Through wise investment and careful management the endowment of the College has increased to about thirty millions of dollars, exclusive of the



DR. CHEESMAN A. HERRICK
PRESIDENT, GIRARD COLLEGE

fourteen to eighteen years of age. Boys born within the old city of Philadelphia (the territory lying between the south side of Vine Street and the north side of South Street, and between the Delaware and Schuylkill Rivers) have first claim for admission. The next group of boys to be considered are those born in the state of Pennsylvania outside of the old city, and after those in turn the boys born in the cities of New York and New Orleans.

plant, but not all of this is at present interest-producing investment.

BOARD OF CONTROL

Girard provided that the care of his College should be assumed by the Mayor, the Aldermen, and the Citizens of Philadelphia and their Agents, the then corporate title of the city. In the earlier years the Board of Control was chosen by the Councils of the City for a brief term. With frequent changes, divisions in the Board, and the uncertainty of policy because of these changes, this method of control was found not to be to the interest of the College, and by act of the Legislature, approved June 30, 1869, the present Board of Directors of City Trusts succeeded to the earlier plan. This Board consists of twelve directors, chosen for life by the Board of Judges of the Courts of Common Pleas of Philadelphia, the Mayor of the City, and the Presidents of Select and Common Councils, *ex-officio*.

The Board manages not only Girard College, but the Girard Estate, parts of which are extended to other purposes, and numerous other bequests.

ADMINISTRATIVE SYSTEM

Girard College has a staff of 465 employees, each of whom is assigned to the supervision of a head of department. The principal departments are: Admission and Discharge; Infirmary and Health of the College; Domestic Economy; Steward's Department; Household and Playgrounds; and Education. Briefly, the activities of each of these departments are as follows:

The Superintendent of Admission and Discharge receives applications for admission and investigates into the qualifications of applicants. The officers of this department act as field agents for carrying on numerous investigations affecting the welfare of the boys who are in the institution. They supervise the admission of boys, and find them positions when they are about to leave, and, by means of visits to employers and reports received, help boys after they go out.

Girard College has an adequate hospital equipment, with a resident physician in attendance. The Infirmary, and, in general, the health of the College are under the supervision of a visiting physician, and working with him are such specialists as a consulting physician, a consulting surgeon, and ophthalmologist, a nose, throat, and ear specialist, and a consulting surgeon for nose, throat, and ear. In connection with the Infirmary is a dental clinic, with a dentist-in-chief, three assistant dentists, and a clerical and mechanical assistant, all four of whom give their full time to the service of Girard College.

The Department of Domestic Economy has charge of all the distinctively household arrangements of the College, such as the preparation and serving of meals, care of clothing, cleaning of buildings, and, in

general, the duties that would be performed under the direction of a mother of a family.

The Steward is the chief business agent of the College, and in this capacity does the purchasing under the direction of the Board, and has responsibility for the care of the grounds and buildings.

The Household and Playground work is under the general direction of the Supervising Prefect. He is assisted in his duties by an assistant who is a Playground Director, seven instructors, a gymnasium instructor, three industrial supervisors, four house-masters, and a corps of fifteen prefects and twenty-two governesses. In general, the duties of prefects and governesses are those of a house father or house mother. They are responsible for the care and welfare of the boys when they are not in school.

The educational work of the College is under the general supervision of the Vice-President. The numerous schools of the educational system are described below.

GIRARD COLLEGE SCHOOLS

An educational institution Girard College is composed of three schools; a Primary School of three years, a Grammar School of three years, and High School of five years. Each of the years above mentioned is divided into two terms, with promotions and commencements at half-yearly intervals. To complete the full course in the College in regular order would take eleven years.

Boys who are ambitious and capable can complete



HIGH SCHOOL BUILDING, GIRARD COLLEGE

the course in less than the allotted time. The practice of doing two terms' work in one by means of extra study and preparation for examination during vacation is not uncommon.

The curriculum for the High School Department places a strong emphasis on studies in English, history, and general science. During the last two years in the College a boy is required, under direction of the education department, to select specialized work, either in mechanical instruction or in commercial studies, and he gives a considerable part of his time to the special department which he selects.

Preparation is given for the following mechanical pursuits: Trade Drawing, Carpentry and Woodworking, Machine Shop Practice, Electrical Construction,

Foundry, Forge Practice, Smithing, and Printing. Practically all the job work needed by the institution is turned out by the students of the Printing Department, under the supervision of the instructor. The age at which boys leave the College makes it impossible to equip them as journeymen in the trades, but they are given a start which enables them to get credit for approximately two years' apprenticeship.

On the commercial side, instruction is given in bookkeeping and office practice, commercial geography, law and customs of business, and shorthand and typewriting. Whichever of the above courses a boy may take during the last two years in the College, the aim is so to equip him that he will be able, when he leaves the institution, to make himself of such use at employment that he can, at least, provide for his own maintenance.

RELIGIOUS INSTRUCTION

In no particular is the work and influence of Girard College more misunderstood than in the matter of its religious education. This is probably due to an early and widely circulated biography of Stephen Girard which represented him as an atheist, a representation for which there appears no adequate foundation. Great publicity was given to the defense of the Christian religion by Daniel Webster in attempting to break the Girard will, but the Supreme Court of the United States decided there was no ground for the apprehension which prompted the attack.

The exclusion of clergymen has been interpreted as being hostile to religious teaching. The Founder said, in express terms, that the provision for the exclusion of clergymen was introduced so that the minds of the boys who were being reared by the institution might be kept free from the confusion of denominational

controversies, and this was followed in the will by a statement that it was not to be interpreted as being a "reflection upon any sect or persons whatsoever."

The first book brought to Girard College was the Bible, and the Bible has always had a foremost place in the teachings of the institution. The difference between Girard College and most other institutions is that religious instruction at Girard College has been given by laymen and not by ecclesiastics. No meal is eaten in the institution without the invoking of the Divine blessing. The assembling of the College for chapel service, of which a part invariably is Scripture reading and prayer, is a daily practice. On Sunday two chapel services are held, and at these services addresses are delivered either by some member of the official staff of the College or by a visiting layman.

RESULTS

The work of Girard College is far-reaching and its service incalculable. Many thoughtful persons have expressed the opinion that the benefaction is one of the greatest that the world has ever known. More than 9800 boys have been the recipients of the services of the institution, and they have gone out into all walks of life to worthy accomplishment and noble living. As recently expressed by one of the graduates, the importance of the work of the institution cannot be realized unless one considers what would have been the future of those who were and are wards of the College if such an institution had not existed. Thousands of boys who would otherwise have been dependents or delinquents have, by the ministrations of the College, been trained into reliable and useful members of society. Such a service has properly given the institution a high place in the admiration and esteem of the world.

The Committee on Publication has been fortunate in being able to present in the preceding pages of this issue the symposium of articles on educational institutions in Philadelphia and vicinity which offer opportunities for technical training. The Committee gratefully acknowledges its indebtedness to Mr. J. W. Ledoux for his unflagging interest in the preparation of these articles.

In this time of testing democratic government when we are most actually concerned in the organization of our national resources for the defense of our principles and of the institutions which have been built upon and around them it seems fitting that we should present this review of our facilities for technical education. This nation is

fully embarked upon a course of action in which force and resources will be the determining factors to a very large degree and the test of our knowledge and ability to use our possessions is upon us. There is now but little time in which to train and educate ourselves for this supreme task. It is for us to apply the results of our study and experience rather than to seek for learning, at this hour. We take up our portion of the burdens of this contest with confidence that our principles of government will prevail. This confidence springs in no small degree from the teachings and influences of our institutions of learning, and in our scheduling of resources we may list as good assets our institutions for technical training.

ADDRESSES PRESENTED AT THE FORTIETH ANNIVERSARY ENGINEERS' CLUB OF PHILADELPHIA

THE PRESIDENT: It is very gratifying, gentlemen, to see so many of the Philadelphia engineering profession gathered here to-night. We are here to feast and to celebrate the Fortieth Anniversary of the founding of The Engineers' Club. The members of the Committee who made arrangements for this banquet are so very modest that they have left their names off this menu. There seems to be no line in which the engineering profession is not called upon to take a hand, and if any one wants some one to handle a banquet, I would most heartily recommend Bob Yarnall and his efficient Committee. I think they have handled this affair very successfully to-night.

We are here to celebrate the founding of The Engineers' Club of Philadelphia because we believe that the men who founded the Club did an excellent thing for the engineering profession. We believe that the men who are developing the Club to-day and who are going to develop it in the future are doing an excellent

thing for the engineering profession. There is no professional club—and I say this without fear of contradiction—that offers so much to the young professional man as The Engineers' Club of Philadelphia. It is becoming one of the greatest centers for engineering men in this country, and we have in our membership men representing all branches of the engineering profession. As a rule, engineers are looked upon as a very serious class of men. They take life rather seriously, and are inclined to work over their problems at night, on Sundays, and even at their meals. I frequently see a waiter rush up with a pad to an engineer, when he starts to make a drawing on the table cloth. We wanted for Toastmaster a member who, no matter how dry the paper had been, could bring out some interesting and humorous point. We haven't any doubt of the ability of the man we selected to do this, and I take a great deal of pleasure in turning the rest of the evening over to Mr. John C. Trautwine, Jr.

TOASTMASTER'S REMARKS

I HAVE here greetings from two of our members, whom we should have been particularly delighted to have with us. The first is a telegram from our Honorary Member, Thomas A. Edison:

The courteous compliment involved in your kind invitation makes it difficult for me to say that I cannot possibly attend the banquet. Am busy day and night on experimenting for the Government, and, under present conditions, must ask to be excused. Many thanks to you all!

EDISON.



JOHN C. TRAUTWINE, JR.

At the Club's organization meeting, Mr. Charles E. Billin was presented by the chairman, Mr. Coleman Sellers, Jr., whom I am pleased to see with us this evening, and who stated that the proposed formation of The Engineers' Club of Philadelphia was due to a suggestion from Mr. Charles E. Billin.

In his delightful story of old Philadelphia, "The Red City," the late Dr. S. Weir Mitchell asked the question: "If Shakespeare's father had married another woman, or if he had married the same woman a year later, would 'Hamlet' ever have been written?" And I ask you to picture to yourselves where we should be to-night if Charlie Billin had drifted

away to the wild and woolly west before (instead of after) the 17th of December, 1877.

The second greeting which I have to read is from our first secretary, Father Billin, who writes as follows to our ex-president, Dr. Carl Hering:

400 WEST END AVENUE,
NEW YORK, March 30, 1917.

Mr. Carl Hering,
Philadelphia, Pa.

DEAR MR. HERING:

Upon my return, after three weeks in St. Luke's Hospital, I find your kind letter of the 21st. I had hoped to be able to attend the banquet commemorating the Fortieth Birthday of the Club, but to-day my master, the surgeon, says "No." I am more than disappointed, as it would have given me great pleasure to have met again my friends of the early membership and made the acquaintance of some of the "hustlers" among the newer members.

Perhaps my good friend, Professor Haupt, will preface his remarks "Forty Years Ago" with a few words as to the "pre-historic" meetings which led up to the organization of the Club. I have not Professor Haupt's address with me or I should write him direct.

During the Centennial Exposition in 1876, in Philadelphia, the National Engineering Societies maintained headquarters in Girard Street and also in the Main Building at the Exposition. I remember one day at the Exposition that Mr. John Bogart, then secretary of the American Society of Civil Engineers, said to me: "Philadelphia Engineers don't seem to know one another. Every day I have to introduce one Philadelphia Engineer to some other Philadelphia Engineer. Why don't you fellows get together?" That remark kept recurring to me, and the following

FORTIETH ANNIVERSARY

winter I invited some twenty or thirty Engineer friends to spend an evening at my home in West Philadelphia; we had some refreshments and talked "shop," and I suggested a series of social gatherings of Engineers and their friends. Meetings, with constantly increasing numbers, were held at the homes of Percival Roberts, Jr., Charles A. Ashburner, Charles A. Young, M. R. Muckle, Jr., W. H. Sellers, and Coleman Sellers, Jr. This latter meeting was on December 17, 1877, when the Club was formally organized and Professor Haupt was elected the first president of the Club.

Professor Haupt's enthusiasm and good judgment were large factors in establishing the Club on a permanent footing, and I am sure that his remarks on "Forty Years Ago" will be an interesting account of the early days of the Club. I regret more than I can tell you my inability to be present at the banquet.

The Club should become a great influence for good in the development and progress of the city and the state. Its recent remarkable growth speaks well for its "active spirits," and I feel sure that under its present efficient and progressive management it is bound to take its place as a constantly increasing

power in the advancement of the best interests of the Engineering profession.

Yours very sincerely,

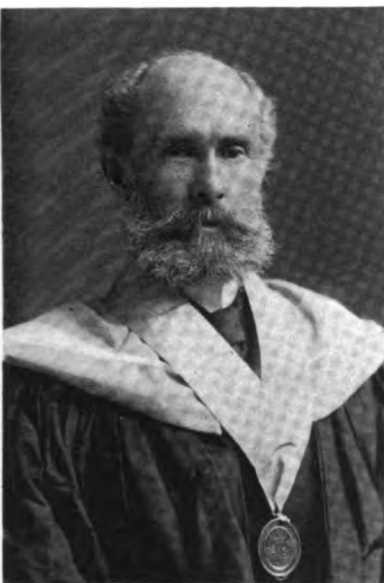
(Signed) CHARLES E. BILLIN.

Some one has said that the man of fifty is to be envied rather than the man of forty; because, at fifty, a man is in the youth of old age; whereas, at forty, he is in the old age of youth. But this applies only to individuals, not to an organization like The Engineers' Club. "Men may come and men may go, but I"—says the Club, like the brook—"go on forever."

Who will say that our Club is in the old age of youth? Who will say that it is forty years *old*? The Club is forty years *young*—young enough and fortunate enough to have with us, this evening, our first president—Lewis, the well-beloved Mr. Lewis M. Haupt who will tell us about what happened "Forty Years Ago."

MR. PRESIDENT and members of The Engineers' Club, I need not say that it is a great honor for me to have the pleasure of being here to address you this evening.

I want to congratulate the Club on having for its fortieth president as my successor a man of learning—of wisdom, dignity, and ability. Mr. Charles E. Billin also is a very dear old friend, and certainly an excellent executive officer in the early days of the Club, and but for him I doubt very much whether we would have survived;



LEWIS M. HAUPT
FIRST PRESIDENT
Engineers' Club

but I am here to tell the tale of evolution. Of course, there are some others, fortunately, to prophesy.

I shall, however, try to be an exponent for those nineteen charter members of the Club by giving a sketch of some of the things leading up to the organization of the Club by reference to the history of some of the things—the first things that occurred in engineering in this country, city, and state, in order that you may understand the difficulties which natu-

rally beset the engineering profession, the necessity for close analysis and close coöperation, standing shoulder to shoulder, so that the desired consummation may be reached early and well. I was admonished that I must put my remarks on paper. I have complied with that request and will take the liberty of reading the condensed record of some of the events which have led up to our organization.

Thirty-and-ten years ago our forbears brought forth,

in this City of Brotherly Love, a new organization, conceived in peace and dedicated to the uplifting of their professions, for the benefit of the nation.

The founders were a coterie of young men having in view the installation of a little plant, for coöperation in their several occupations, by the publication and discussion of professional theses; and, feeling the necessity of a "governor" to regulate the movement, they selected an adolescent professor of the University of Pennsylvania as its foster father.

Fortunately, the plant survived, and, like the great banyan tree, threw out many suckers, which have taken root under its branches and have served to prop them up with their plethora of fruitage.

Some of those early members were men of large vision who, in due time, were called to positions of honor and responsibility in the city, state, and nation, and it would seem fitting to remember them, both living and dead, by calling the roll. They were: Charles A. Ashburner, Charles E. Billin, George Burnham, Jr., William Burnham, G. H. Christian, Jr., O. B. Colton, Herman Hoopes, Theo. J. Lewis, Henry C. Lewis, Wilfred Lewis, M. R. Muckle, Jr., W. G. Neilson, Percival Roberts, Jr., Coleman Sellers, Jr., Horace W. Sellers, Howard Sellers, William F. Sellers, Charles A. Young, and your servant (19). On December 17, Mr. Coleman Sellers, Jr., was elected vice-president and Mr. Billin secretary and treasurer. By March 1, 1879, the membership had increased to 72 and to-day it has reached the magnificent total of nearly 2400 and the end is not yet.

THE BACKSIGHT: FIRST THINGS

Things are not spontaneous: they are the offspring of mind. Originality, invention, execution, knowledge of physical laws, as well as the psychologic moment for their application, are essential. *Progress* is based upon experience and implies familiarity with the "state of the art," hence it is fitting to look backward to ascertain our bearings for future advancement.

Mind is the active element necessary to direct and

utilize matter. In Provincial days Philadelphia was the "cradle of liberty" and held the first rank as a commercial centre in the Colonies. Later it became the capital of the nation.

This was in large measure due to the initiative of a few of her citizens, in conjunction with a poor apprentice who migrated from Boston, where he was born January 17, 1706.

This runaway youth of 17 (in 1723), popularly known as "*Poor Richard*," was a printer who used his press to great advantage as a means to an end, with the result that in 1743 he organized the first scientific society in America, now known as the American Philosophical Society, and ten years later, in 1753, laid the foundation of the school which has grown to be our great center of learning—the University of Pennsylvania, which has given to the nation so many distinguished men in science, art, literature, and religion, and has been the alma mater of so many of the able and illustrious members of this organization. It is recorded of Franklin that in 1745 he experimented with electricity—then unused.

The first surveys for our public works originated with Dr. David Rittenhouse, the astronomer, of this city, and Dr. William Smith, first provost of the University, who, as members of the Philosophical Society, were commissioned in 1762, to make a survey to connect the Schuylkill and Susquehanna Rivers by way of the Tulpehocken and Swatara Creeks; and in 1764 they induced the same Society to authorize the survey for the existing Chesapeake and Delaware Canal, while the provincial legislature also authorized the surveys of connections with Lake Erie and the Ohio River for the western trade, which were subsequently built with numerous laterals, covering in all some 946 miles, at a cost of over \$40,000,000.

The first canal act was passed to build the Union Canal, September 29, 1791, but it languished for many years from lack of finances, and in the meantime the Schuylkill Navigation Company was opened in 1825. The Union Canal followed in December of 1827, and the Chesapeake and Delaware in 1829.

But few of these valuable works survive, yet they were fully justified in their day and served a useful purpose. Their history is full of romance and the sequence is worthy of careful consideration, because of the increased rates for transportation on some of the essentials of trade manufacture, and still the *coastwise canals* remain undeveloped, notwithstanding their vital importance to the welfare of the nation for defense and traffic.

But, to complete the early history as to the inception of the idea, it is recorded that more than a century before, or "in 1613, Sir Samuel Argal wrote home to England that he had hoped to see a cut made between the bays of Chesapeake and Delaware;" and, in 1690, William Penn also alluded to the practicability of effecting a communication by water between the Susquehanna and a branch of the Schuylkill, which was not commenced till a century after.

The Modern Universal History says: "There is an

easy communication with Maryland which comes within four miles of the Chesapeake Bay, and that a project was once set on foot (in 1763) for joining the river and bay by an artificial canal, but it met with such opposition from the inhabitants of Virginia and Maryland that it came to nothing."

Thus it appears that sectionalism was as prevalent then as now, and as it was in the national opposition to the opening of the Erie Canal under Monroe's administration, in 1811, which compelled the Empire State to provide the relief desired from her own resources, and which gave her the supremacy she now so happily enjoys, due to her foresight and courage.

When the states bordering the Chesapeake and Delaware Bays, with their 50,000,000 tons of interchangeable commerce, awake to the sense of their responsibilities and resources, it is hoped these coastwise canals may be modernized and be made available to the nation. In this laudable work the Engineers' Club has hitherto taken a keen interest, which should be continued until the goal is reached.

But waterways are of no use without vessels, and those which can make the most trips and carry the greatest tonnage are the most efficient and profitable, so that marine and maritime engineering have given to the world its floating palaces which, as shuttles on the high seas, should weave together the nations of the earth.

The germ of this wonderful evolution for speed was budding in the brains of artisans in past centuries, but a clockmaker and surveyor of Philadelphia—John Fitch, born January 21, 1743—conceived the idea of applying steam to navigation in 1785, while at Neshaminy, Bucks County, and he built a boat in Philadelphia, which made its trial trip, July 27, 1786, on the Delaware. It was propelled by vertical oars connected by rods worked by cranks. Later he made improvements, and in 1790 ran about 3000 miles to Trenton and Wilmington at a speed of eight miles an hour. The engineer frequently finds his greatest obstacles arise from incredulity or prejudice; they are psychological rather than physical. This is an important factor in all great public improvements to be reckoned with at their inception. A case in point is that of John Ericsson, which may point the moral. He was born in Sweden, July 31, 1803. In 1828 he built a steam fire engine and offered it gratuitously to the city of London, which thrice had been nearly destroyed by fire. It was opposed on the ground that it would have to keep its fire constantly burning, it was too powerful for common use, too heavy for rapid traveling, and required more water than the streets supplied, but, even if sufficient, it would be injuriously applied and damage property. Although it was operated for five hours continuously, when all the hand-machines were frozen up, it was not permitted to be generally introduced in England and was sent abroad. Such was his first experience with official inertia and prejudice. In 1835 he patented his screw propeller, and in 1837 it was placed on the *Francis B. Ogden*, a vessel 45 feet long, which had two wheels of

5 feet 3 inches applied to the stern, and it ran at a speed of ten miles an hour. She also towed a 140-ton schooner at seven miles and the boatmen called her the "Flying Devil," but the engineers of London regarded the experiment with silent contempt.

The following summer (1838) the Lords of the Admiralty were taken on an excursion on the Thames at ten miles an hour, and on returning expressed their disappointment, stating that "even if the propeller had the power it would be altogether useless in practice, *because*, the power being applied in the *stern*, it would be absolutely impossible to make the vessel steer." Commenting on this physiological condition of mankind, Hayden said: "How I hate the expression, 'It will never do'! It has always been the favorite watch-cry of those, in all ages and in all countries, who look on all schemes for the advancement of mankind as the indirect reflections on the narrowness of their own comprehensions." Commodore R. F. Stockton, of New Jersey, was at that time in London, trying to raise money for the building of the Delaware and Raritan Canal. He saw the experiment on the Thames and said: "I do not want the opinions of your scientific men; what I have seen to-day satisfies me. We'll make your name ring on the *Delaware* as soon as we get your propeller there." This drove Ericsson to America in 1839, where his propeller is still working on the Ericsson Line between two great commercial centers, and he also helped to save the nation at a critical juncture by the timely construction of the *Monitor*, which checked the ironclad *Merrimac* in Hampton Roads, Sunday, March 9, 1862. This first ironclad, the *Monitor*, was launched at Greenpoint, N. Y., January 30, 1862, and cleared for Fortress Monroe in command of Lieutenant Worden, March 6. On the 8th the United States war vessels *Cumberland* and *Congress* were destroyed by the *Merrimac*, from Portsmouth, Va., and on the next day, the 9th, she was engaged by the *Monitor* and rendered *hors du combat*.

Thus the conservatism which opposed the genius of a foreign engineer abroad operated to enable him to defend his adopted country in a great crisis, and to maintain its flag, the symbol of liberty and opportunity. He died in New York in 1889. The original *Monitor* turned turtle in a storm off Hatteras, December 31, 1862, "and became a coffin for sixteen of her crew." The Navy Board, in reporting on Ericsson's offer, recommended, on September 16, 1861, that an "experiment be made with one battery on the terms proposed, with a guarantee and forfeiture in case of failure in any of the properties and points of the vessel as proposed." Price \$275,000, time 100 days, draft 10 feet, displacement 1255 tons, speed nine statute miles per hour. On the Mississippi River the illustrious Jas. B. Eads was also converting snag-boats into ironclads similar to the *Merrimac* in 1862.

The history of the application of steam for transportation on land is also one of interest, and it was attempted before the construction of trains or even turnpikes were in use, so that the general introduction of

the automobile of to-day had its prototype in the steam carriages for common roads in the eighteenth century. Among the first to introduce this motor was Oliver Evans, a blacksmith and artisan, born 1755 in Philadelphia, who had faith to predict that "The time will come when people will travel in stages, moved by steam engines at fifteen to twenty miles an hour. A carriage will leave Washington in the morning, breakfast at Baltimore, dine at Philadelphia, and sup at New York *on the same day*. Railways will be laid of wood or iron, to travel as well by night as by day.

"A steam engine will drive a carriage 180 miles in 12 hours. . . . Posterity will never be able to discover why the legislature or Congress did not grant *the inventor* such protection as might have enabled him to put these great improvements in operation *sooner*, he having asked neither money nor monopoly of *any existing thing*. (Signed) OLIVER EVANS."

He therefore applied his ingenuity to other operations where the door was open, and constructed a machine for cleansing docks. It was a large scow with engine and boiler and machinery, for driving wheels upon which it was mounted for transit on land, and with a stern paddle-wheel for propulsion on water. He ran it from his shop on Vine Street to the Schuylkill and then around to the Delaware. Thus it was both an automobile and a dredge—built about 1781. He offered a bonus of \$3000 to anyone who would race the fastest horse against his engine and beat it, but there were no bidders. He died April 21, 1819, or before the era of canals or railways.

But it is not possible to review the evolution of the numerous elements which are now available to our profession in the brief time available. Suffice it to say that the *Proceedings of the Club* for 1884, vol. iv, No. 3, page 148, contains a chronological table giving the dates of introduction of many of these improvements.

In 1877 the Engineers' Club of Philadelphia was organized. Its aspirations were high and many of them have been realized, but there are others which must be fulfilled to keep pace with the ever-increasing demands of civilization.

To improve these conditions the Club submitted and discussed numerous papers relative to the removal of the islands in the harbor; the organization of research laboratories for investigation of the properties of materials; the proper planning of cities as to facilities for transit, relation of public to residential areas, water supply, drainage, sewerage, location of manufacturing plants, grade crossings, central stations, elevated and underground railways, pavements, parks, boulevards, distribution of population, food supplies, sanitation and methods of securing these desiderata, with the opposition, which resisted any innovations looking to the general good by local or personal interests.

As early as 1877 the diagonal system of streets was proposed, radiating from Broad and Market Streets, and elaborated in connection with other diagonals in

1881, culminating in the greatly-extended system so well applied by Past President S. M. Swaab in his annual address of April, 1915.

The Rapid Transit discussions of 1884 led to the securing of charters for underground traffic in 1888 by rival parties *pro* and *con*, so that in 1892 August Belmont, of New York, undertook the construction of an elevated structure, the foundations and part of the superstructure for which were erected in 1893, but vested interests interposed so many obstacles that the work was suspended and the company dissolved. All the puerile objections which were urged as to the impossibility of adapting existing conditions to underground transit have since been overcome, and now, that still greater facilities are an absolute necessity for normal growth to relieve congestion, the same contest rages as to who shall build, control, and operate this public utility and where it shall be located to serve the people.

These are but a few of the many civic improvements which the engineers have initiated for the public weal, and it is a source of congratulation to find that, with a greatly-augmented membership, the efficiency of this Club is so largely increased as to make it a still more potent factor in the growth of the city, state, and nation.

It is impossible to trace the development, since that date, in detail. Suffice it to contrast conditions as to public services and utilities as they exist with those of forty years ago for the measure of the progress which has resulted from the coördination of engineers, financiers, and legislators, all of which constitute the elements so essential to the general welfare.

The engineer often finds himself restricted by the failure to secure the necessary rights of eminent domain or to find sufficient capital to enable him to execute his projects, so that he is not always responsible for failure to complete well-designed improvements. Many important works have been compelled to defer their consummation for years, because of hostile or vested interests, for fear of competition, and yet in most cases it has been proved that such competition was of great benefit. In great enterprises it is evident that no single group of engineers can fulfill all the legal and technical conditions which must enter into the completed work, and hence the necessity for intimate coöperation of the many classes of Civil, Mechanical, Hydraulic, Sanitary, Electrical, Illuminating, Heating, Mining, Maritime, Marine, Architectural, Chemical, and Municipal, so that when this Club was organized it was christened, broadly and wisely, THE ENGINEERS' CLUB OF PHILADELPHIA, to give it a local habitation and a name.

Now, Mr. President and gentlemen, I would like to have called attention to some of the early things and projects recommended by the Club, but as you have an able speaker here who is thoroughly familiar with this matter from the beginning to the end, I am going to sur-

render my right of way to my distinguished friend, Mr. Swaab.



THE TOASTMASTER: Mr. President, I repeat my suggestion, and request that our First President let us have the text of his admirable paper for publication in the Club Proceedings.

I have received the following telegram from the Aero Club of America:

(Western Union Telegram)

Engineers' Club, Philadelphia, Pa. NEW YORK, N. Y.
Banquet Bellevue-Stratford.

Aero Club of America, in conference assembled, extends fraternal greetings to Engineers' Club of Philadelphia upon the occasion of its Fortieth Anniversary and suggests your vigorous coöperation in furthering aerial measures for national defense and immediate passage of legislation providing universal national service.

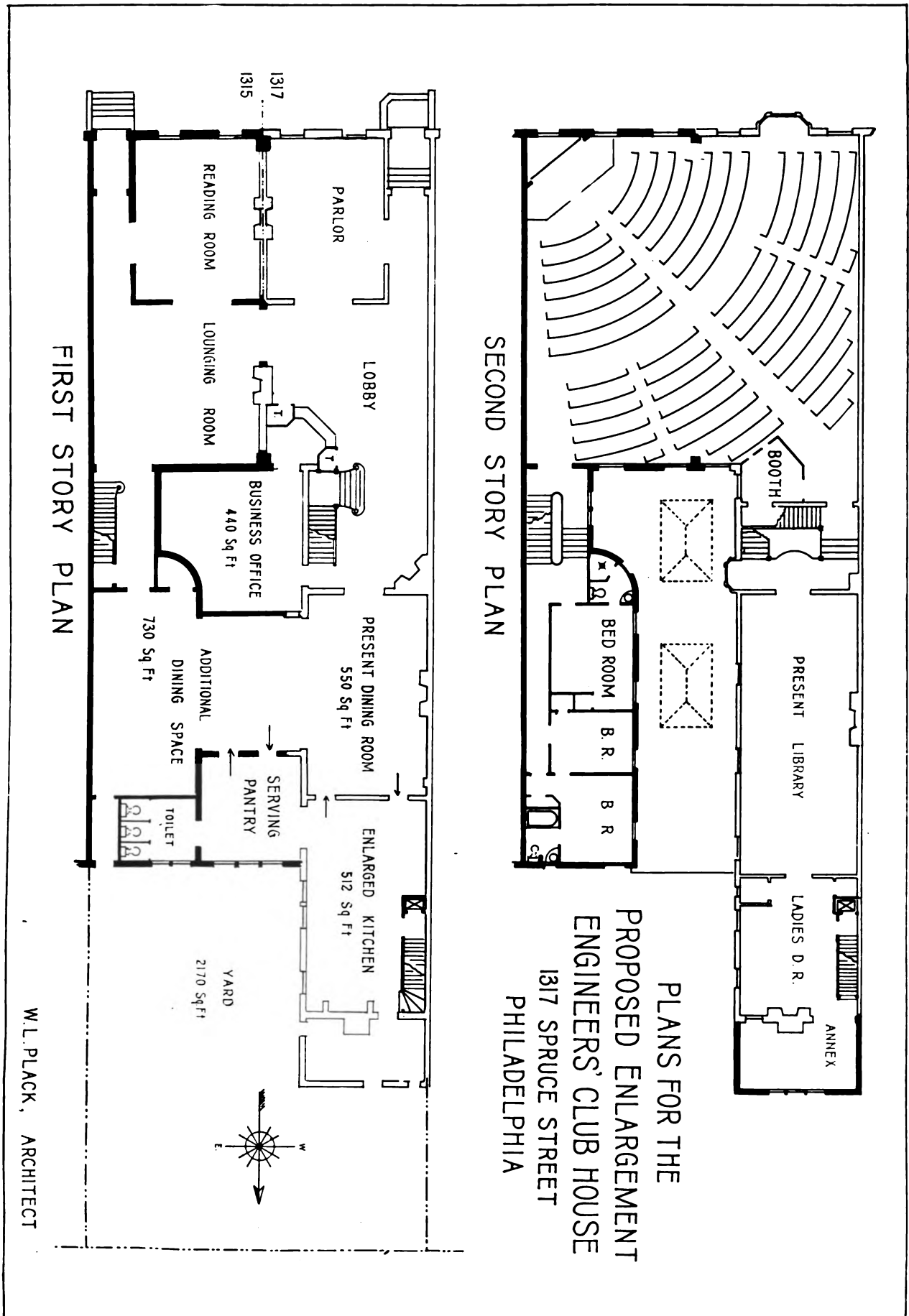
JOSEPH A. STEINMETZ,

Order ALAN B. HAWLEY, *President*.

THE TOASTMASTER: As a result of the whirlwind campaign of a couple of years ago, the membership of this Club was approximately quintupled. In round numbers, we jumped from 500 members to 2300 in a few days, adding nearly 400 per cent. to our membership. Of course, this has brought a vast amount of new life and of new blood into the Club. Like everything else, new blood has its little drawbacks. Formerly, when we old fellows dropped in at the Club, we felt as if we belonged there. Now, when one of us drops in, the 400 per cent. look up and ask: "Who is this old hayseed? How did he drift in?"

As you all know, each of our presidents lives but one year. Then along come the By-Laws and knock off his official head, and down he goes. Now, that has a curious effect—like the mathematicians and the English sparrow, our ex-presidents multiply rapidly. Those of you who can remember the pre-whirlwind days will recall that our little membership of that time was rapidly degenerating into a saturated solution of ex-presidents; you couldn't throw a stick in any direction without hitting two or three of them. Of course, the increase in our membership has greatly diluted the solution. In fact, the genus is becoming a rarity. However, the Banquet Committee has succeeded in capturing, for this occasion, several "specimens"—most of them located at the ex-presidential table (indicating) and a few of them seated here in the "king" row. And one of these last, who perhaps knows at least as much about Club Development as the rest of us, will now tell us a little of what he knows about that art. I call upon Mr. S. M. Swaab, the hustler of the organization.

NOTE.—Mr. Swaab's address. "Vim, Vigor, and Victory," appeared in the April issue of the PROCEEDINGS.



THE TOASTMASTER: I do not like to sound a discordant note in these agreeable proceedings, or to find fault with what any speaker has said; but, when anyone says "new club house" it awakens painful memories. Some ten or fifteen years ago, while we were struggling along in Girard Street, a misguided Club or President put me upon a committee to consider the improvement of our quarters. That Committee met, with some degree of faithfulness, for many months and got absolutely nowhere. One of our ex-presidents, in his retiring address, grilled us by quoting, from the minutes, a statistical account of the meetings and adjournments of that well-intentioned committee. I congratulate the Club that the present move for a new building is in charge of a committee which has demonstrated its disposition and its ability to *do things*.

St. Paul is said to have said, "If a man *work* not, neither shall he *eat*." To a body of engineers, familiar with the laws of the conservation of energy, I need not say that the converse is equally true, and that, if a man *eat* not, neither shall he *work*. Therefore I am gratified to learn, from Mr. Swaab, that the Building Committee has not overlooked the important matter of "eats."

Mr. President, a patriot is one who desires his country's welfare. It is therefore important for the patriot that he make no mistake as to wherein that welfare consists; that he know on which side his country's bread is buttered. On the Fourth of July we still let off firecrackers to celebrate the fact that, in 1776, our forefathers set up in business as a separate nation. No doubt those old boys thought they were doing a fine thing. But let us not judge them too harshly. That was more than a century ago. The world was large then, and the nations were small and widely separated. They were not then so vitally dependent upon each other as they are to-day. In those days men could imagine that nations could have conflicting interests—that one nation might hurt another without at least equally hurting itself; they could not be expected to realize, as we do, that each nation's *chief* interest is the welfare of *other* nations; but to-day, as we begin to grasp something of this elementary and Christian notion, we find ourselves wondering what might be the condition of the English-speaking world to-day, if our forefathers could have arranged to put up a little longer with the eccentricities of George III. Indeed, our patriots of to-day seem to be in a fair way to re-cement that bond between Britain and America which the patriots of 1776 thought it so fine a thing to break.

And similarly of those nineteen who met in the Club Cradle at 3301 Baring Street, in December, 1877. I fully agree with our President's sentiment that they did a good thing. This Club has been a source of satisfaction and benefit to all of us; but it must be remembered that, in forming an institution of their

own, they were virtually adopting a Declaration of Independence in separation from their elder brother—The Franklin Institute—which then, for more than half a century, had been conferring distinction upon this city. Might they not have done still better in coöperation with The Franklin Institute? I am a member—as many here are—of both organizations, and I was therefore delighted to hear Mr. Swaab say that the Committee had in view the establishing of closer intimacy between these two institutions.

In what way, and how far, they can coöperate—all the way from frosty non-intercourse up (or down) to actual merger—I must leave for the practical men to decide. As a mere theorist, I record my impression that the real criterion is "the greatest good to the greatest number," and that coöperation always spells efficiency. I express also my gratification in being able to call on Dr. Walton Clark, president of The Franklin Institute, to tell us something about our elder brother.

MR. WALTON CLARK: Mr. Toastmaster, gentlemen, members of The Engineers' Club: I also am an apologist; I also have a serious subject, and, having a serious subject, and being mindful that in The Franklin Institute we try to be exact, I also have a written speech.

THERE dwells in the heart of every man the desire to walk according to the light as given him, to square his conscience with the truth as he knows it. No man does, or can, know rest until his actions, called by the world criminal or called by the world exalted, have been justified at the bar of his own conscience; until he is able to say of what he has done, "I had a right to." I think this fact is the most stable thing we have to tie to in our dealings with men, though in things spiritual or intellectual it is the father of sophistries. In things spiritual, men reconcile all sorts of queer behavior to their sense of what is due them. But in dealing with physical science their sophistries avail them not. The logic absolute of the foot rule and of the alembic admits no sophistries. Men cannot reconcile to their consciences and their intelligence anything in science but the truth, and they can be counted on in so far as they have to do with scientific investigation to strive for the truth. I have had



DR. WALTON CLARK
PRESIDENT
THE FRANKLIN INSTITUTE

some experiences illustrating how various may be the striving in character and in result.

Nearly forty-five years ago I was a boy around the New Orleans Gas Works—where, by the way, I made my first acquaintance with the *Journal of The Franklin Institute*. Being a helper to a pipe-fitter, I was one day engaged with my boss in making a certain connection between a recently-erected gas condenser and the main tar drain. We were in the shop cutting pipe when the boss said to a laboring man who was helping us, "Mike, go out to the condenser room and bring me the measure of the distance between the two-inch hole we just cut in the condenser and the two-inch tee on the tar drain." Joyfully, Mike went—on his first independent responsibility—and a few minutes later, being sent on an errand, I met him crossing the yard. He was stiffly holding his index fingers about eighteen inches apart, and he called out to me in apprehension, "Don't run agin' me; I got a measure." This laboring man, unfamiliar with the intricacies of a two-foot rule, was doing his best according to his lights in carrying out the orders of his boss and bringing him accurate information.

Forty years later, Mr. Crisfield and I, being concerned with the operation of a certain small electric generating station, and not having sufficient condensing water, were discussing the utilization of a hole in the ground near the station, and owned by us, for cooling pond purposes. The question of its size naturally arose early in the discussion. Mr. Crisfield said to a cadet engineer of very recent graduation, who was with us, "1915, go out and measure the size of that hole."

The young man was new to us, and I observed his preparations for the work with considerable interest. He sorted the tripod of his altitudinous theodolite from his golf sticks in the corner of the room. He put his slide rule—known to the profane as a "guessing stick"—in his hip pocket, from which it projected over a foot. He took my steel tape line, on which he had carefully theretofore determined the error due to changes in temperature; he put a memorandum book in his pocket, called an assistant, and went.

Three days later I asked Mr. Crisfield if he knew the size of the hole. He said that "young '15" was just completing his report. It was a remarkable report. He gave the capacity of the hole in cubic feet and cubic yards to the second decimal place, with side notes as to the equivalent in the metric system. He gave the weight of the ashes it would take to fill it. He informed us how long it would take to accumulate those ashes in our plant, using the coal we were then using, with our then efficiency and with the load that the new business department had told us to expect. He discussed the wisdom as to tamping the ashes or settling them with water. He called attention to the fact that, inasmuch as we might want subsoil structures on the spot, it would be wise to fill the upper six feet with clay. He gave information as to where the clay could be had and how much it would cost. He gave comparison of the cost of filling the hole with ashes by

wheelbarrow and by cart. He drew attention to the importance of studying the influence of the hypothesis of the fourth dimension as useful in solving such problems. In conclusion, he respectfully called our attention to the fact that we could probably not put out bonds for the work and that the whole cost must be charged to operating. It was really a beautiful report.

So, from the nineteenth century to the twentieth, from the gas-house terrier to the highly specialized and differentiated product of a great university, we find an earnest effort to develop and report the truth: one man failing because of his ignorance; the other, in the pride of knowledge, wasting time in the accumulation of undesired data, adding to that mass of undigested and valueless facts that is clogging the intellect of the world.

The Franklin Institute has a place for each of these men. Its schools for the untutored—there would be learn accurate methods; a bench at its lectures for the overtrained—there would he learn the beauty and dignity of reserve. And since no man may be trained in accuracy or in reserve without spiritual betterment, we may claim for The Franklin Institute that its beneficent effect upon the state and citizen is to be measured not alone by its success in promoting the Mechanic Arts.

The Franklin Institute was organized in the year 1824 to meet a demand in America for an institution similar to that founded by Count Rumford in London in 1799. The founders intended it not only as an appropriate memorial to the name of Franklin, but as means of continuing for all time a work which throughout his long life he perhaps regarded as his best; namely, the discovery of physical and natural laws and their application to increase the well-being and comfort of mankind.

The hall of the Institute, located on Seventh Street, between Market and Chestnut Streets, was built from plans furnished by John Haviland, architect. The cornerstone was laid in 1825. The funds for the purchase of the lot and the erection of the building were provided by the issue of a building loan, which was taken by members and friends of the enterprise, and has long since been repaid or forgiven. The building was completed, and the Institute took possession, in 1826, of all except the second floor, which was occupied by the United States Courts until 1830. The Institute still occupies this beautiful and appropriate building—practically perfect in every detail but size. The third floor is given up entirely to the School of Mechanic Arts. The second floor is occupied by the library. Upon the first floor are located the lecture-room (capable of accommodating about 300), the offices, and laboratories. These latter, once ample and suitable to the needs of the hour, have shrunk in importance as physical science has developed until now they are practically of negligible importance.

The plan of our founders contemplated "the formation of a library of books relating to science and the useful arts, and the opening of a reading-room;" and, accordingly, in 1827, the first Committee on Library was appointed.

The founding of the *Journal*, in 1826, by opening the way to the establishment of exchange relations with other societies and with the leading magazines and periodicals devoted to science and the useful arts, proved an invaluable help in promoting its growth, and thus early gave to the library the distinctive character which it has since maintained. At the present time the collection of books consists of 68,492 volumes and 29,716 pamphlets.

One of the things apparently uppermost in the thoughts of the founders was the need—as urgent then as to-day—felt by inventors and discoverers of some competent, trustworthy, and impartial body to whom they could safely appeal for advice and on whose judgment they could confidently rely for an opinion as to the usefulness of their inventions and discoveries. This is the function of the Committee on Science and the Arts. Its work is too well known to demand any extended notice here. During the past twenty years the committee has investigated over 900 discoveries, processes, and inventions.

The publication of the *Journal* has been continued without interruption to the present time. The object of *The Franklin Journal*, as defined in the prospectus, was, "To diffuse information on every subject connected with the useful arts."

The first Board of Managers of the Institute provided for the establishment of a standing Committee on Instruction, charged with the duty of directing its educational work. This committee speedily perfected plans for systematic instruction by means of lectures and demonstrations. Professorships in chemistry, in natural philosophy and mechanics, and in architecture, were established and filled by the election of capable instructors. Provision was next made for the instruction of mechanics and apprentices and those engaged in the useful trades, and early in 1824 a school of mechanical and architectural drawing was established. About sixteen years ago classes in mathematics were established; these later became a part of the school of machine design. Instruction in naval architecture was first given in October, 1899.

Lectures have always occupied a prominent place in the scheme of the Institute's work from the beginning to the present. For many years the lectures were of the nature of regular courses on architecture, mechanics, physics, and chemistry, varied, of course, from year to year, but following generally the plan of graded or consecutive instruction, as in schools and colleges. This system, however, though for a long period admirably useful in meeting the needs of the public, was found in time to be gradually outgrowing its usefulness. Lecture courses on scientific themes, which for years had been practically preëmpted by The Franklin Institute, in time were made attractive features in the schools and colleges, and the popular science lecturer became a conspicuous figure on the public lecture platform. So the Committee on Instruction found it advantageous gradually to modify its lecture program to adapt it to the changes of the times. For a number of years the character of the Institute lectures had departed widely from the old-time

pattern. The object at present most conspicuously kept in view in the selection of the lectures is to give the members of the Institute the advantage of having presented to them the latest advances in the useful arts and the sciences bearing thereon; and, to this end, the committee's efforts each year are directed to the purpose of securing the services of men of eminence in their respective fields of labor, who are invited to select their own themes. Since its foundation The Franklin Institute has given free to the public thousands of such lectures by distinguished scientists and technologists on scientific and technological subjects, in addition to numerous popular and illustrated addresses on subjects of immediate interest to the public and germane to the topics of the day.

General meetings of the Institute's membership are held once each month. At these meetings great inventions and discoveries, important engineering projects, and notable achievements in all fields of scientific progress are presented, exhibited, or discussed. Many of the epoch-making inventions have been shown in their experimental stages at these meetings, as the phonograph, the electric light, the typewriter, liquid air apparatus, machine telegraphy, etc.

The holding of exhibitions as a means of promoting the mechanic arts was highly favored by the founders, and in this field of activity the Institute has been conspicuously prominent.

I have no detailed knowledge of the financial affairs of the Institute during the first eighty years of its existence. It must have had quite a checkered financial career. This is the fate of such institutions. That The Franklin Institute has not escaped the fate of its kind is evidenced by the obligations and liens created by its management, the evidences of which still exist. The Institute was started with loans; it has borrowed from its members on never-expected-to-be-paid notes; it has had sundry mortgages on its building; it has issued so-called first-class and second-class stock; it has been robbed; and within my own experience it has run with heavy annual deficits. However, because such good work as it has done cannot continuously fail of support, because such work is sure to enlist not only the financial but the active personal aid of able men, the Institute has survived all its financial perils and to-day is out of debt, except as between departments of the Institute itself, and has an income sufficient—though barely sufficient—to its immediate needs.

Our financial condition is, briefly, as follows: The Institute owns the scene of its present activities at 15 South Seventh Street. It owns nine dwellings at the corner of Nineteenth and Race Streets, the property facing Logan Square. It paid for this property approximately \$210,000. It has endowments of practically \$580,000. It has a fund for a new building of approximately \$260,000. Exclusive of the building which it now occupies, and the contents thereof, it has assets of approximately \$1,050,000. Its annual income, mainly from its endowment funds and membership dues, is approximately \$47,000; and it spends its income. The children of this

generation of a family which for three generations has been prominent in the Institute's affairs, and is now represented on the Board of Managers, are creating a Trust Fund to be devoted under the guidance of the Institute to research in pure physical science. This is in addition to the above funds. With the acquisition of this research fund will be realized one of the ambitions of the officers of the Institute—to be able to begin again, under modern conditions and to meet modern necessities, the unselfish investigation of subjects having to do with pure physical science. The managers of the Institute would be proud if they could claim that the greatly improved financial condition of the Institute was due to their efforts. There are generous men connected with the management who have liberally helped the Institute in its time of need, and indeed I could name a few to whose liberality the continuance of the work, through what I believe must have been the most trying period of our existence, was mainly due. But the large sums of money that have come to the Institute in the last few years have not come from the personnel of the management or because of its direct influence. They have come as legacies from people who have known the Institute and of its work, and who, seeking to leave some portion of their wealth where it would help to promote the interests of mankind, have selected The Franklin Institute as a fitting instrument to the accomplishment of that end. The above condition and record justify us in expecting that others seeking to invest their money where, through the encouragement of physical science and the mechanic arts, it will do most good to the people, will place such money in the care of the Institute.

It is from such a source that we hope to receive the money necessary to the erection of a larger Franklin Institute building on Logan Square and the Parkway. When? is an open question. Whether, in this uncertainty, this Club of Engineers would be justified in postponing the formulation of its plans for a greatly-needed new club-house, that we might try to work out a scheme of mutual assistance, is for you to decide. The Institute has no club features. Its every energy is devoted to the promotion of the Mechanic Arts. In no way do, or reasonably can, the Institute and the Club compete one with the other. The management of either or both would be crude indeed to permit it. There will be no rivalry. Coöperation there conceivably might be if the Institute were now in funds to erect a building. There should be one great engineering library and one series of scientific lectures common to the use and aid of all the engineers and physicists of Philadelphia and vicinity. There never will be too much money available for this; there never will be any to waste on competition.

I realize the impracticability of this Club—which should be a Club great in influence as well as in numbers—postponing its building plans to the unknown date of the erection of a new building by the Institute; yet I still hope that a plan may be worked out that will result

in one library and one auditorium for the common and convenient use of each.



THE TOASTMASTER: Gentlemen, I have never been able to observe that our British friends, at this day, harbor any serious resentment against our people here on the score of the little rebellion undertaken here more than a century ago; and I take it that if the historic nineteen erred on the 17th of December, 1877, the fault has been forgiven and forgotten by The Franklin Institute, whose President, like ourselves, is a member of this Club, and who has come here to join us this evening and tell us something of the great organization over which he presides.

Celebrating our bigness, we must bear in mind that we are, nevertheless, but a *local* organization—and that, as such, it behooves us to take off our hats to the "Big Four"—the four great national engineering institutions—The American Society of Civil Engineers, The American Society of Mechanical Engineers, The American Institute of Mining Engineers, and The American Institute of Electrical Engineers—and I am happy to be able to call upon the President of The American Society of Mechanical Engineers to tell us something of that institution—Dr. Hollis.

MR. TOASTMASTER, Mr. President, and Gentlemen: I have not written anything for this meeting to-night, in order that I might speak somewhat at random if the occasion seemed to justify it. Really, I have a better claim to come here than that stated

by your presiding officer, because I was the first President of the Engineers' Club of Boston. As a former President and now a member of that Club, I can bring you greetings of Boston and New England, as well as the greetings of the American Society of Mechanical Engineers.

I ought not to be here to-night at all, as I was appointed by the Mayor of Worcester, ten days ago, the Chairman of the Committee on Public Safety. This means a



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AMERICAN SOCIETY OF MECHANICAL
ENGINEERS

great many things that do not seem to be included under the word "safety." The first thing it means was the examination of all bombs picked up by the police in various parts of the city. One arrived at my office a few days ago,

having been found in front of the Mayor's door. Inasmuch as the agreement with the Chief of Police to examine bombs included a bomb-opener from the Police Department, I found myself in some quandary about the contents. We took this bomb, which was small and heavy. The police stated that there was some hard substance inside that rattled, while I heard nothing but the splashing of a liquid. The Professor of Chemistry and I took it to the top of the chemistry building, the Professor of Chemistry having been generously permitted to carry it. We dropped it to the pavement, thinking the shock would cause it to explode. It apparently had a plug in each end, and we discovered one of the plugs had been displaced. After trying several times to explode it by shock, we took it to the machine shop and gave it to the foreman with instructions to put it onto the saw and then to go off and leave it. He did this, and left it for half an hour, but it didn't explode. When it was nearly cut in two, I removed it and found it was a solid piece of metal. I do not know what the Chief of Police heard on the inside of it!

The next bomb was—an order from the Mayor to organize the women of Worcester in the interest of relief. This could not be side-stepped, and I addressed the ladies on relief, requesting them to form some organization representing all of the women's societies, for the purpose of backing up the Red Cross in the relief of the city after any kind of disaster. And I want to say to you, gentlemen, this is not quite so funny as it really sounds. We have been on the trail a number of times that seemed to lead direct to some kind of conspiracy against our industries and our means of communication. I pray God that through watchfulness and the organization of special police recruited from our citizens we may come through the agitation of a declaration of war without a breakdown of any kind.

It would be comparatively easy to destroy some of the great industries; and it would seem almost fatal to blow up the water pipes of any city. Our Home Defense League in Worcester, our Committee of Relief, is the greatest safeguard against suffering. The ladies I met represented all nationalities and all religions. They came from all walks of life; and I have yet to see better Americanism, greater devotion to country, and greater willingness to make sacrifices that we may come out of this terrible struggle with a larger freedom of mankind.

There is one aspect of this, however, the subject of conspiracy in the United States that I cannot leave without just a word. There will doubtless be some explosions, and there will surely be the acts of some misguided people who hope by violence to assist a mother-country against the United States; but I do not at all believe in any widespread conspiracy among the Germans. Those who have been born in this country, and those who have been naturalized, and even visitors who are at work here, have the same stake in the future welfare of the republic and in conditions under which labor must be carried on, and so they are not likely to go crazy. Widespread conspiracy would be lunacy of the most foolish kind, and the Germans are not fools. I think we may depend upon the great body

of American citizens, whose Fatherland has been, in the near or remote past, that military power called Germany. They will serve with us and they will suffer with us. Let not the deeds of cranks and unbalanced individuals cause us to perpetrate an injustice against our friends and relatives who have come from Germany.

These good women who talked over with me the organization against accident and against disaster that might kill a number of our people if we should go to war, from which pray God we may be relieved by a fair concession of justice on the high seas, and who listened to the discussion, one after the other rose and said: "We have come here principally to offer our homes and our buildings for the use of this city in case of necessity. We have come here to offer our help. We will combine as one body of American women towards the safety of this city and towards its relief."

I am sure that is the spirit throughout our whole country. Hence, when I speak to a body of engineers in regard to this crisis, I feel it unnecessary to urge them to do their duty by our country—something may be taken for granted; and we should face our obligation quietly, with the determination that we are going to be Americans, and not an hysterical crowd that can be stampeded into exaggerated action. I have just come from the West, where the people of the Mississippi Valley talked to me about the false notions of their attitude. They seem to have a resentment against New England, on the ground that New England has seemed to treat them as less interested in the welfare of the country than is the Coast. They have been accused of being lukewarm with regard to war. Who in our country is not? We all hope there may be no war; but we also hope that American rights are going to be respected throughout this world and that men and women are not going to be murdered in the ambush set up on the seas. I heard nothing else than this while I was in the Mississippi Valley—nothing but the demand to know: "How can we serve this country of ours?" Buffalo, Detroit, Chicago, Milwaukee, Minneapolis, Lafayette, Indianapolis, New Orleans, Birmingham, Atlanta, Columbus—all asked the same question: "How can we serve our country?" Is it unnatural, then, to take something for granted, and on that ground to refrain from urging men to serve?

At Santiago the *Merrimac* was sent in to be sunk across the mouth of the harbor. The undertaking was conceded to be extremely dangerous, consequently a request was made that eight volunteers offer themselves from the flagship for service in this hazardous attempt. It seemed to be the only way of selecting men. It proved, however, to be a poor way, because every man in the crew volunteered; some of them wept because they were not chosen to take the chance of dying for their country! America from one end to the other has this same spirit. It is one of the great ideals that we saw in the Civil War and that we would have seen in the Spanish War in case it had lasted longer.

It occurred to me here to-night that I might say a few words on Engineering Democracy. I have put those

words together because I firmly believe that the future of democracy on this earth is tied up with the engineering profession. They have grown up together. The republics of Greece and Rome in the ancient world were not republics in our sense of the word. They had no such conception of individual freedom as mankind has had since our Revolutionary War. The modern democracy, of equality of opportunity and of freedom to develop one's self in one's own way for the service of mankind, is new. Our Declaration of Independence has expressed it. Our flag has but one meaning—that it has been in the van for 150 years to the greater liberty and happiness of the world, and it is planted on the summit which we hope all men will attain.

Our Revolutionary War is often treated as a revolt against taxation without representation; but that phrase is a mere expression of revolt against exploitation of a people in the interest of a privileged class or a governing class that attains its control by birth rather than by merit. Mr. Trevelyan has written the best history of our Revolutionary War, because he treats it as a revolt against a dynasty. George III, not the English people, was the enemy of the American Colonies. Consequently the result of that war was just as much for the freedom of English citizens as it was for the freedom of the individual in the Colonies. It was the beginning of a breakdown in the monarchical system. The French who served in our armies carried back to France our ideal of liberty and our conception of government. Lafayette it was who became the great leader in the beginning of the French Revolution. I cannot help but feel that the great change in France was a direct consequence of our Revolutionary War. It was carried into the bloody years under the guillotine because of the combination of the dynasties of Europe to keep Louis XVI on the throne. It is no wonder that the French people went mad when they found the royal families combining to choke out this little spark of liberty in Europe for fear that it might grow into a flame that would sweep them away. France was attacked, and the bloodshed in Paris began with the beheading of the king. I am not among those who deplore the French Revolution. The old system that prevailed in France, where the miserable peasant was exploited for the benefit of the land-holder, had to be washed out in blood. I only pray that we may not have the same thing in Russia. Poor old Russia, that has been under the heel of the despot for so many centuries! Even China has come into the list of democracies.

The period of the past 150 years has been a more and more powerful struggle against privilege by birth and government by those born to the purple. England has become a real democracy. France is the very flower of democracy in this struggle against Germany. It was *our* little war in America that lighted the fire, and it is only natural that we should share in the last push that will topple over the monstrous tyranny that has existed so long in this world. Under monarchical systems there could be no such thing as "Love thy brother as thyself."

Equality of opportunity, human rights, the freedom to develop one's self, will make that precept a reality on this earth.

Consequently I look upon this war to-day as the last stand of autocracy against the freedom of the individual. That is why America can be on only one side. That is why all Americans feel not unfriendly to Germany, as our President has stated it; and that is why so many Germans in this country feel the American spirit. We despise the military caste that tramples on a country, and we sympathize with our German friends who still retain a love for the Fatherland under such adverse conditions. We feel, as many of them feel, that we cannot permit that autocracy should again control this world or that we should drift back into another period where liberty will have to begin again. I may say that we were in at the birth of the newer freedom; and now we are going with the other nations to the funeral of autocratic power. If that is not true, all this bloodshed is for nothing.

Now, at the same time that the American Revolution was thought out, an obscure mechanic in Scotland improved the steam engine into a crude machine with a great development in store for it. That, gentlemen, was the beginning of labor-saving machinery, and it was the beginning of the great age of invention. So many things have sprung out of it that the history of the past 150 years covers a far greater span of progress than all recorded history preceding James Watt! The invention of the steam engine was also the real beginning of the broad profession of engineering. Up to that time the world's history had been really the history of invention, but the engineering profession had not been separated off in such a way as to make understood its influence upon the life of mankind on this planet. The history of political acts is, after all, nothing but the record of passing events and of a passing philosophy—the causes of this history lying far below and relating to the material welfare of our people. We have many examples of the ultimate cause of great political changes in small inventions, apparently insignificant at the time: the cotton-gin, the sewing-machine, the locomotive, as well as the steam engine, figure as the active agents of great social change. Most of the problems of to-day are connected with them in some way. I do not think it an exaggeration to speak of woman suffrage as closely related to the invention of the sewing-machine.

It is unnecessary for me to go into this subject very deeply before an audience like this. I do want to call your attention, however, to the very interesting growth of democracy and the profession of engineering, side by side. How far has Engineering promoted democracy, and how far has Democracy promoted the initiative that underlies invention? I cannot escape from the belief that the two have gone together, and that one cannot survive without the other; and that upon Engineering we depend for the maintenance of Democracy on this earth. Our Civil War would have been lost but for the railroads; and the West would be a foreign country to us but for the

same agent. The countries across the seas would be so separated from us by distance that we should know little of them if the steamship, the telegraph, had not come to reduce the earth in size.

Some engineer or some historian ought to trace out the relative influence of Engineering and Democracy on each other. I am sure it would form a most inspiring parallel for men and women outside of the profession, as well as for those in it. Furthermore, it might give us a conception of engineering as citizenship, in addition to being the developer of resources and materials for the well-being of mankind. I think, then, it is peculiarly the duty of the engineer to go forward in this great democracy of ours, to give money and time and effort and blood towards the spread of human freedom and the continuance of our conception of government.

In connection with war, gentlemen, we have one great truth in history, and we may well think of it for a moment here. It is much easier to get into a war than it is to get out. And, further, when one goes to war, one can state the reasons for going into war much better than one can state the issues that are going to come out of it. No one could have predicted a year or so ago that one of the results of this war would be the disappearance of the Romanoff dynasty. Nobody knows now what other dynasty may disappear. I pray God that all of them may go. In other words, the issue of this great war on the other side of the Atlantic is a question, really, of the attitude of mind of the individual toward government—whether that government shall own him, or merely be the instrument through which the freedom of the individual is found, the equality as to opportunity and the initiative that creates in every man a delight in work.

There is one aspect of this to which America ought to pay attention. We have almost carried the idea of liberty and equality into a debauch. On the Court House in the City of Worcester is the sentence: "Obedience to Law is Liberty." That is the finding of all history and of all philosophers in all the records handed down to us. We must learn that, just as we must learn freely to give ourselves to this great cause in behalf of mankind. We must not forget that there are 40,000,000 soldiers under arms, and that the sound and smoke of the guns are over all Europe. Into this mess we are plunging, without preparation, almost heedless, to put it, of the fact that war requires as much training as any profession. How can we contribute the last punch that will topple over the absurdity of the semi-feudal system in modern times? It is only by preparation, by work, by study, and by training. We forget the meaning of the word "efficiency"—that it is the elimination of waste. Every engineer understands that, and for that reason he is the man who ought to offer himself. Efficiency is the ratio between a desired result and the cause that produces it. That applies to the moral situation to-day as well as to manufacturing. No efficiency has any value unless it has a moral purpose behind it. If it leads simply to some method by which a beer bottle or even some article of wearing apparel is made

cheaper than before, it amounts to nothing; but if it leads the world to the conception of freedom, that makes of efficiency the instrument through which man attains his highest happiness and highest satisfaction in this life, it is of real value. If efficiency does not enable a man to serve his fellow-man and his country better; if it does not make him a better citizen, and array his mind to that attitude of obedience, submission, and willingness in the service of other men, it is not worth thinking of.

As a matter of fact, efficiency has three aspects: *first*, that of the individual; *second*, that of the corporation or the combination of individuals; and, *third*, that of the government. As applied to the individual in America, the word is well understood, and no nation can surpass us in the initiative and efficiency of individuals, especially among the engineers. In that which relates to the coördination of individual efficiency, toward the highest development in manufacture and in transportation, we have learned in part that individuals must sacrifice enough to permit them to work together. Their permission to develop themselves has to be safeguarded by attention to collective action, but we have little to learn about that. Our factories have developed splendidly. We do need however, to pay attention to the ethical side of the whole question in relation to our trade unions and their activities in America.

There is a third efficiency, however, that must be considered, and that America has not yet learned, in its own government. We find, in a book called "The Cult of Incompetence," by Faguet, an interesting reference to the incompetence of democracy on account of the failure to train men for their work under government. We have dealt with this subject somewhat in the smaller occupations in Washington, especially those in the scientific departments and in some of our Civil Service offices, and yet we have done nothing effective in relation to training for the job that ought to exist in appointments to the higher positions. What great corporation would ever consent to a political appointment to office under its management? What corporation would ever think of taking the editor of a small paper as secretary of a great department spending anywhere from two hundred to four hundred thousand millions of dollars in a year? Such a corporation would be fit only for an insane asylum, and we know that perfectly well. Yet we do not apply this to government. Any business corporation would be ruined under government methods.

We all pray that the country may be successful in its combat in war against Germany, but, unfortunately, we have not as much faith as we would have if the heads of the two military departments had learned, by experience, the management of the business before us—at least so far as preparation can provide against disaster and war. This whole thing has a pathetic side to it. I am not referring so much to the question of incompetence, because I believe Americans are quick to learn their work and to profit by experience; but we have a sorry spectacle in the way certain problems are approached. I do not call it incom-

petence, but it is a lack of imagination consequent upon inexperience. Here we are, in the face of a declaration of war, when we are going to need the best organizing skill of the entire country to weld 1,000,000 men into an army. Have we any man who stands out as distinguished in his power of organization, both by experience and by his command of men? Yes, we have. He is Leonard Wood. His term of office is up. He has finished his four years at Governor's Island, and in the ordinary times of peace he would be due to move elsewhere. And yet our country has no more imagination than to offer him the Hawaiian Islands or Charleston, S. C. It is not necessary to call that by so harsh a term as "incompetency," but it is the same old lack of power in the administration we have always had in Washington.

Of all men who could be chosen to assist us in this great crisis, we have selected that one to live off some place in a hole where he can have no influence. I do not mean that Charleston is a hole, in the sense of its not being a very pleasant city to live in; but it is a hole in the sense that Leonard Wood is taken from a position of power and helpfulness and sidetracked where he can do nothing. That is what I refer to when I am discussing the efficiency of government in the United States.

I feel, gentlemen, that it is absolutely necessary for the engineer to take his part in educating the public in the meaning of the word "efficiency," and what it signifies to our government if the citizens of our entire country demanded preparation and training for the office to be filled. We *must* educate the public. We *must* take our share as citizens. There is a certain element of truth expressed in the old story about a Secretary of the Navy who discovered that the ships of the navy were hollow. Of course, that is absurd, and yet there is a certain amount of truth in the statement made in that exaggerated and frivolous way. We, as engineers, can help in this, not by destructive criticism of everything in the nation at the present time, but by a demand, after this crisis shall have passed, that efficiency mean the saving of everything, in material, in energy, and in waste in government. All the great administrative positions, including the Senate of the United States and the Congress and Cabinet, must be filled by men who at least have a fair knowledge of the subjects with which they are dealing. Let us pound this day after day into our fellow-citizens, through our societies and through individual effort.

This is not intended to encourage the engineering societies or the sections to set themselves apart from the administration at the present time. Whatever mistakes may have been made by *this* administration or any past administration, in the conduct of our affairs and in that preparedness which might have safeguarded our country against this war, we are united now. I have been a Republican all my life; but I am to-day as good a Democrat as can be found in the country in my determination to back everything that this administration will do towards effective demonstrations against the Central Powers of Europe.

It has been difficult up to the present time to discover just how engineers might be useful. In going around the country, I find always that question—"What can we do?"—and I have not been able to answer, because the War and Navy Departments have been more or less chaotic in their treatment of the constructive plans necessary for war. It has been very difficult indeed to find out just what the orders really mean. The Engineering Corps and the Army began, some months ago, and they have made progress towards a Reserve Corps, but it was not well done, because the preparation should have contemplated all the corps of the army—the Quartermaster's Corps, the Aviation Corps, the Signal Corps, the Infantry, the Cavalry, the Artillery, are just as important as the Engineering Corps; and until recently nothing was effectively done to call attention to that fact.

I advise this Club to get all of the orders issued by the War Department and the Navy Department, so that they can be hung up where all the members of this Club may see them. Then if anyone wishes to volunteer for service he may write to the appropriate department and bureau for blanks to fill out and information as to what to do. Write to the Adjutant-General of the Army and to the Bureau of Navigation of the Navy for information. They will try to answer. Of course, both Army and Navy Departments are swamped with letters at the present time, and they have not yet caught up with the organization required to handle it. You may have to wait a while, but ultimately the whole business will be cleared up. Every war that we have had has shown the same kind of confusion and inefficiency. It is the price we pay for democracy; and I, for one, am willing to pay ten times the price rather than go to the other alternative—Prussianism, the spy, and deliberate preparation for bringing on war at some fixed time. Inefficiency, however, is not a necessary accompaniment of democracy, so that we do not have to pay this high price, if we are willing to contemplate proper preparedness.

There is always a thought with which I like to close in addressing a body of engineers; a certain fancy that comes into my mind in connection with the growth of science. It is this: When some creature, centuries ago, took up a club and began that long journey into the Land of Reason which made him a human being, he had crossed the shadowy boundary that divided man from the creatures of instinct. It is the long age of reason through which we have been traveling. Is it too fanciful to say that the flower of invention in the present century is showing us a new era when man shall have developed perhaps a sixth sense that will give him a quick understanding of every man; that will give him a faith in the Almighty and that "meekness which inherits the earth"?

I cannot help but feel that we are just now starting into a growth which in a few thousand years will make these men who are fighting in Europe look as if they belonged to a crude and shadowy past, where, as some poet has said, "Our light will seem but as shadows to those who come after." I hope that may be so, and that our

descendants may have something so far superior to that which we know that we will seem but the crude forefathers of an enlightened age. I *know* that the engineer has his share in this; and I know that through his working towards the greater light he will find his greatest happiness. Let us all do our share for the glory of our country.



THE TOASTMASTER: In regard to Dr. Hollis's suggestion, that this Club get into communication with the authorities and secure information as to the methods by which its members can coöperate with the Government in any possible approaching crisis, President Carter tells me that such action is already being taken, and, furthermore, that if those in charge have not made as great progress as they could have wished, this is due to the fact that they have not received, from headquarters, the information upon which further action must be based. The President tells me further that he has been appointed, by Mayor Smith, a member of the Committee on Enlistment.

Mr. President, I thank God (or evolution—call it what you will) for Exhibit "A" (indicating Dr. Hollis). In the first place, Dr. Hollis, although connected with the Navy for nearly twenty years, has said things here this evening which, if he should say them at the meeting in Independence Square to-morrow afternoon, would land him in the guard-house. In the second place, here is a man who represents that industry—of which (as Colonel Zinn has told us) the product is "killed and wounded men," and yet, with sublime disregard of the interests of his profession, he prays God that that profession will not soon get busy killing Americans by the hundreds of thousands.

Now, observe Exhibit "B" (indicating himself): I am the meanest kind of pacifist. I never was much of a runner, but I had always rather run than fight. I am too mean to ask one of you to undergo loss or hardship in defense of my little possessions. Far less would I ask the 100,000,000 people of these United States to go to war, sacrificing hundreds of thousands of lives, for any interest of mine. I have therefore no interest in any war for selfish national interests—for aggression, or even for "the defense of our fire-sides." *But*—assure me that, in concert with the other decent nations of the earth, our country would go in with any prospect of establishing that super-nation which shall forbid and suppress that childish international anarchy which still calls itself "patriotism" and which renders wars inevitable—assure me of this; and—old as I am—I will (if permitted) shoulder a musket (for the first time).

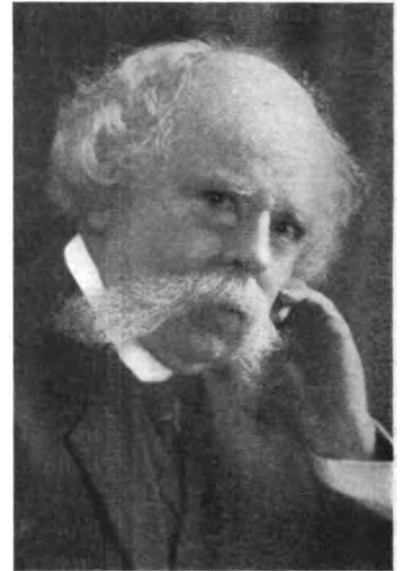
Mr. President, in Philadelphia no occasion of this kind is complete without a word of cheer (he has no other kind) from the City Statistician and City Booster.

So now, with malice toward none; with charity toward all; with firmness in the right, as God gives each of us to see the right, let us finish this agreeable work we are in by receiving the benediction at the hands of this High Priest of Optimism, this sweet singer of "*Philadelphia über Alles!*"—Dr. Edward James Cattell.

MR. TOASTMASTER, honored guests and members of this wonderful association: I am happy to congratulate you on your Fortieth Birthday. Looking at some of you I might almost double that. I see a great many of the constellations, and I possess a bald head,

too, but I hope that you have all learned, as I have, that you never see cheap furniture with a marble top. I am glad to be here and have that charming introduction from my dear friend Trautwine. I have been crying with the rest of you as we have attended the funeral procession of our Army and Navy, and the surrender, before the battle began, of the United States. I am delighted to share in the hope that two thousand years from now my grandchildren—and I have got to start soon, for I am an old bachelor—will be able to be happier than I am; and they have got to get up early in the morning if they get more out of life than I get. I have not gone to bed the same day I got up for fifty years, and I have a sign in my office at City Hall which reads, "If a pretty girl passes and I do not notice her, send for the Coroner; I'm dead." Having in all these years found life such a demnition grind, and being perfectly willing to take any amount of bad medicine to keep me from going to that heaven pictured by our friend from New England, and so easily enjoyed by all accustomed to their climate, I am inclined gratefully to remember an experience of mine at a negro camp meeting, where a clergyman said, "There are two roads, brothers—the broad road that leads to perdition and the narrow road that leads to damnation." One of the darkies in the audience said, "If that is true, this nigger takes to the woods."

Now, I am pretty well satisfied with life; I am pretty well satisfied with dear old Philadelphia. I know we are sometimes called slow. I know we are called sleepy, but when you think what we do in our sleep you will know what I mean when I say, God help



E. J. CATTELL,
STATISTICIAN, CITY OF PHILADELPHIA.

the rest of our world when we wake up! I was asked to buy a horse some years ago; I found he could make twelve miles an hour—ten up and down and only two straight ahead. But that's not Philadelphia. I was asked one time in New York by the President of the Chamber of Commerce why we people in Philadelphia walk so much slower than people in New York. I said, "I don't know, but perhaps it is because, having money in our pockets to pay our bills, we are not afraid to have the man behind catch up." Not long ago I addressed a gathering of men out in Chicago. The Toastmaster had gone out of his way to say some pretty nasty things about our city, the dead; and so I was tempted to say I loved Chicago; that if I had to die I wanted to die in Chicago; then, no matter where I landed in the next world, I'd be damned well pleased with the change. Now you can see that I am also a pacifist; that is, I act like a pacifist. I never fight and never hit back. I believe that instead of having men to die for their country they ought to shoot so as to make the other fellow die for his country, and leave him there.

Gentlemen, I recognize the difficult position I occupy, following a magnificent line of speakers and having to speak at several other places in the meantime, and there comes back to me that splendid verse in the 13th Chapter of Deuteronomy—or perhaps it is the 12th—where Jonah said to the whale, "This thing wouldn't have happened if you had kept your mouth shut." When I praise this Society I do it from my heart, and while on that subject I want to remind you of this fact. I am old-fashioned and I like to hold to the old King James version, and there is an important difference in the story that everybody here knows—the story of the prodigal son. In the old version "they killed the fatted calf." In the new they "shot the bull."

I believe there are certain things that have to be done, and there are a hundred million that know what to do where you will find one who knows *when* to do the right thing. I took a Scotchman out to breakfast with me about three weeks ago. He ordered three boiled eggs. When the waiter brought them, "Mac" opened one of them and pushed it aside. The waiter said, "What's the matter; wasn't it boiled long enough?" "Oh, yes," he replied, "but not *soon* enough."

There are lots of things we ought to have done, in the matter of preparedness, as you said, sir—many things that should have been done long ago. We are starting to do a few of them. But there are a few evils that cannot be corrected. I think nine out of ten of our evils, however, are within our power of correction. One of the truest, most brilliant utterances was that of a Frenchman—"If a thing is possible, it is done; if it is impossible, we will do it." That applies to America, and I think history justifies my prediction.

I got off at a little railway train that had been

running on a small road in the southern part of Carolina one day, and the first thing that struck my ears was the yelping of a dog. I am very fond of dogs and I asked what was the matter with him. The owner replied, "He is suffering from laziness." I said, "How does that make him suffer?" He said, "He is sitting on a sand-burr and is too lazy to get up." We have met problems like that; we meet them in governmental work when we try to give the people a business administration under laws made by men unfamiliar with business principles. That is what we are up against. Congress every two sessions receives 36,000 bills; passes 400—395 unconstitutional and five unworkable!

I am glad to be here to say just a word about this city that I love, because what would we be in this dear old city without the services of the engineers? There is a little point of difference in the settlement of this old colony that gives the keynote to Philadelphia. In every other section of America the settlers came to America because they believed that it was a good place to live a life of sorrow and suffering as preparation for a happy life hereafter. This life was a pain, a penalty; they did not believe that life is worth living for the here and now. In 1685, William Penn wrote to a friend that he wanted to show in Pennsylvania a people as happy as may be. He believed that the normal condition of man was happiness; that if he was not happy something was wrong with the man—not with God. He believed, however, that happiness was like a shadow: if you follow after a shadow it runs away. It is only when you run away that the shadow follows after. And so Penn preached a happiness through making others happy. We get by giving, but we have got to give first. And Penn also held that no man could be happy who was holden in debt to another, and therefore a slave and not a freeman. In nearly every so-called new law you will find an echo of an idea expressed by William Penn. One of our latest laws—that is, on the purity of foods—contains almost identical language, taken from his writing of 233 years ago: Irrespective of the buyers' ability to check weights and measures or test quality, the exact quality promised in the quantity sold must be delivered. In our latest Bankruptcy Act clause after clause corresponds with those written by William Penn, 230 to 235 years ago. We have our roots deep here in dear old Philadelphia.

I spoke to a family reunion the other day and there were 2500 members of one family! One man there present said to me, "I am occupying a house which is 160 years old—and it is the third house built on the same site!" Yes, we have old ways; we have deep roots, and we have some old-fashioned notions.

I want to give you a sequel to the remark I made in New York about not being afraid to let the man behind catch up. We have in this city, in one savings institution, 290,000 labor accounts with \$136,000,000 to

their credit. This institution has paid \$70,000,000 interest to these wage-earning depositors since it was formed, and the largest increase in the number of new depositors was that of Russians now living in this country—Russians who have just passed from under the rule of the Romanoff. We have more Italians owning their own homes in Philadelphia than any other *ten* cities in America. Speaking broadly, this whole population is prosperous. One hundred and fifty thousand men in this city own the homes in which they live. We have standing to-day 375,000 dwellings, only 15,000 of them frame, with a population of a million and a half—practically equivalent to what New York, on Manhattan Island, puts in 75,000 dwellings, and we have 340,000 taxpayers, against 80,000 in a city with three times our population.

These are hard, dry, cold facts, but they testify a certain breadth in the distribution of wealth, a certain contentment with environment that exists in this city and forms a great asset. Three hundred thousand men of skilled labor—30 per cent. of them of the third generation—live and labor in this one city, each with an open space, square or park, within walking distance of every home.

Now as to our being slow: Every tick of the clock we make twenty-five loaves of bread, ten pairs of stockings, and thirty cigars; every two seconds a new hat. We can build a locomotive every two and one-half hours; every twenty minutes a new home. A new baby is born every thirteen minutes.

These are along the material lines; but there are other things which I am happy to remember. Over a million and a quarter children are alive in America that would not be alive to-day if we had not made in Philadelphia a serum to fight diphtheria! Over one and one-half million soldiers wounded in this great war are alive to-day who would not be alive if we had not made another serum to fight lockjaw!

In Girard College we have an institution with \$32,000,000 of endowment to train thousands of young men for useful lives. The arm of a dead man, Stephen Girard—gone for seventy years from the scene of his great commercial activities—still protects and encircles 1500 orphans.

At another institution endowed by one of our rich men they have been able to make certain discoveries through which at least 25,000 little children to-day are romping in the sunshine—children who would be helpless cripples but for this Philadelphia aid. These are some of the things which testify that we are trying to live up to the old traditions.

Look for a moment at the mere bulk and bigness of the modern city. Do you realize that it would take you twelve years to make a three-minute call at each of the 375,000 homes in Philadelphia? That in these homes are located 325,000 bath-rooms—more than in any other city in America? In Philadelphia a man occupying a six-room house renting for \$16 a month

may have modern plumbing, and his house lighted by electricity and gas; he must have 144 square feet of open space around his house. In Philadelphia the trolley cars go ten times around the earth every day—without going outside the city limits!

I plead for optimism because I cannot help it, my friends. With my own eyes I have seen these Philadelphia homes multiply from 60,000 to 375,000. I have seen the wealth of America grow from seven thousand million dollars to one hundred and ninety thousand million dollars.

When I went to California, on the first railroad that linked the two oceans in 1869, it took me ten days to get from here to San Francisco; in fact, it was built only to Sacramento. The other day I spoke through the telephone to San Francisco; it took my voice the thirtieth of a second to travel the distance that it took me ten days to travel 48 years ago. The age of miracles is not past. I will tell you a story which I told to that San Francisco audience of 1600 people. I said I was standing in the lobby of the Bellevue-Stratford not long ago and I heard a man bragging about San Francisco. The crowd seemed cold, doubting. I cut into the talk, saying, "Yes, it is a wonderful city." He said, "When were you there?" I said, "Three weeks ago." He said, "Three weeks ago? Hell, you ought to see it now!" That is not the note of the funeral march, but then I do not believe in the note of the funeral march; I will give my place to a lady or anybody else who wants to go to a graveyard. I love this life, I believe in the heaven of the here and now. If the people I meet in heaven are half as kind or half as thoughtful of others as I find men to-day here on earth I will be satisfied with that other world. Years ago, in Australia, there was arrested, charged with a misdemeanor, a salvationist. "What is your name?" asked the magistrate. He said, "Sims." "Where do you live, Sims?" "Heaven is my home." "Thirty shillings fine." That is the disadvantage of living in the suburbs. I think there is a little heaven right here now. There is plenty of work to do for the Master right here now, if only we stop dreaming and do our nearest duty first. That is necessary, and we must have a large and cool allowance, have a big stock on hand of gentleness, kindness, tenderness. Just as soon as we each do our full duty we will find things going well for the whole nation.

There are always two ways of looking at a question. A sea captain who came to New York took his parrot into the house of a clergyman friend. The parson's parrot, wanting to be hospitable, turned to the sea captain's bird and said, "What shall we do to be saved?" The bird screeched out, "Pump like hell or go to the bottom." Each had his point of view; each took life as he saw it.

I cannot be pessimistic when I recall my trip to the Pacific Coast in 1869—the first year the Union and Central Pacifics were open—for on that trip we

travelled five days over what every geography in the world called "The Great American Desert." It was absolutely of no value, was not counted in our national assets. To-day, thanks to scientific training and discovery, we are raising three crops a year on many parts of that desert, and a section of land called arid everywhere is now classed as arable. The same thing is taking place all over the country. I can well remember when Proctor Knott, of Ketnucky, made his famous speech in Congress proving that no value could ever come out of the territory now occupied by the states of Wisconsin, Minnesota, Idaho, the two Dakotas, Montana, Washington and Oregon.

Nearly every pessimist is a young man who has a good bit to learn, or an old man who has forgotten everything he had learned.

We have to-day many cheap and nasty educated men who remind me of a certain little boy. He was drawing a picture. His mother asked: "Son, what are you doing?" Said he, "I am making a picture of God." "Why," exclaimed the mother, "nobody knows what God looks like," to which the boy replied, "They will know when I get through with this picture."

There are many things that we will never completely know in this life, but one thing we *can* understand, and that is the art of living—the art of living in a way to make others happy, to bring sunshine, to lift burdens. The greatest of all lessons, it seems to me, is the lesson which the greatest of all teachers brings home to us as the years multiply, and that is, that no man liveth to himself alone.

In this time of crisis let us keep a large and cool allowance, "with malice toward none and charity for all." Let us remember the great interests that are entrusted in our care; let us have faith in the God of our fathers and the principles they lived for and were willing to die for.

I love that flag (turning toward flag) as much as any man who lives loves it. I remember during the Civil War many of the brave lads who gave up their lives for that dear old flag. I helped carry many a wounded fellow from the station then at Broad and Prime Streets.

Looking from my office window, at the southern tower of City Hall, 200 feet above the street, I can always see Old Glory snapping in the breeze. One day last summer I had been so absorbed in work I failed to note the fact that a storm had gathered. Looking out of the window to furl my flag I noticed the clouds had completely swallowed it up. But then a little miracle happened. A sudden flash of lightning cut the horizon and in the center of that path of fire I caught a sight of "Old Glory"—the red stripes that speak of the shed blood of heroes; the white of the purity of our womankind—had found a new power—and then the clouds swallowed the flag up. But through all the rest of that storm, in the eye of my soul I saw our flag still flying. And so, my friends, no matter how dark or heavy the clouds which may at time surround Old Glory the principles for which that flag stands are God-given and, I believe, will be God-protected.



AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS EASTERN PENNSYLVANIA CHAPTER

GEORGE W. BARR, President

GEORGE BOON, Secretary



THE joint meeting of the local A. S. M. E. and this Chapter, held March 27, was well represented by members of both societies; all present are agreed that meetings of this character are beneficial to interests so closely allied, and promotes good-fellowship among members. Those not present missed a treat.

The paper on "District or Central Station Heating" at this meeting, by Mr. W. J. Kline, of the American District Steam Company, was a concise review of up-to-date methods, and the discussion confirmed the opinion that improved appliances have eliminated many difficulties in underground pipe systems; also the fact that the "Meter" and not the "Flat" rate is the only method that should be considered commercially.

The regular monthly meeting of the Eastern Pennsyl-

vania Chapter of the A. S. H. V. E. was held Thursday evening, April 12. The paper on "Warm Air Furnace Heating," by Mr. Irwin F. Grumbein, was not only well received, but renewed the claim that heating and ventilating by this method has many advantages for certain types of buildings, and the proper installation requires the scientific consideration of the Heating and Ventilating Engineer. A majority of those present took part in the discussion.

The next regular meeting will be held Thursday evening, May 8, at eight o'clock, when Mr. C. E. Bonnet will present a paper on "Heat Regulation."

Members are earnestly requested to forward to the Secretary topics they wish to offer for discussion and to give their individual support to the officers in their efforts to promote the interest of the Chapter.



ILLUMINATING ENGINEERING SOCIETY PHILADELPHIA SECTION



ROBERT B. ELY, Chairman

T. ELMER MOON, Secretary

Next Meeting, Friday, May 18, 1917, at 8 P.M., at the *Engineers' Club*. Subject: "A YEAR'S PROGRESS IN THE MANUFACTURE OF MAZDA LAMPS," by UNIT RASIN. Also, Dr. H. E. IVES will continue the "ELEMENTARY TALKS" with an entirely new method of presentation of the fundamentals.

THE regular meeting of the Philadelphia Section of the Illuminating Engineering Society was held at 8 P.M. on April 20, 1917, at the Engineers' Club.

Preliminary to the meeting, Dr. Crampton gave a brief talk on the elements of vision, having subjects there to illustrate various types of diseased and healthy retinas.

The main paper of the evening was presented by H. P. Gage, of the Corning Glass Works, Corning, N. Y., on "Automobile Headlights," a synopsis of which is herewith given.

ROAD ILLUMINATION BY MEANS OF AUTOMOBILE HEADLAMPS (ABSTRACT)

IN order to overcome the dazzling glare encountered when passing automobiles with bright headlamps, and at the same time properly illuminate the road for safe driving, two principles in headlamp construction are involved; namely, diffusion and deflection. The method of diffusion has the advantage that no special adjustment of the bulb and reflector is needed, and the disadvantages, that no warning beam is thrown ahead when approaching blind crossings, and elimination of glare is accompanied by insufficient intensity for driving. The method of deflection has the advantage of illuminating as brilliantly as desired those portions of the road which must be seen, without blinding approaching drivers, and the disadvantages of requiring accurate focusing and adjustment, and that road irregularities or topping a hill will allow momentary glare.

In general this problem has been left in the form of the question: "If glare is eliminated, what light distribution is best suited for driving purposes?" Emphasis should be laid upon the exact extent of the roadway itself, which should be illuminated, or the question as to exactly how much light thrown in the driver's eyes should be considered as dangerously glaring.

It is a comparatively simple matter in the laboratory to measure the intensity of light projected by a parabolic reflector, either alone or combined with some

light-distributing device, and to measure the extent of this beam. But what do these figures mean when the light projector is fastened to the front of a car and the machine is driven at a fairly high rate of speed along a smooth macadam road where many other cars are passing? The answer to this question involves so many elements that we must take each element and analyze it separately.

The first consideration would seem to be the type of road it is necessary to illuminate. These roads may be divided into three types.

Type A is the ordinary country road, on which the motorist meets no obstructions to speak of, and has very little difficulty from glare from any other automobile. The road is rough; the driver has to look out for ruts, ditches, and occasional bridges which are missing. He needs only a comparatively small amount of light, because he cannot travel very fast, yet he can have all the light he wants, because there is nobody to interfere with.

The type B road is the macadamized road. There are a large number of automobiles on pleasant evenings, a constant stream going in both directions, and there is a great deal of difficulty caused by glare. Also, there is present the occasional horse-drawn vehicle without any light or a carefully-concealed one.

Then there is the Type C road, the city or independently lighted road. There again the headlamp situation is simple; headlamps except as position markers are not needed.

ROAD ILLUMINATION VS. GLARE

The statement has been made that in order to get sufficient road illumination for comfortable and safe driving a beam of light of such high intensity is required that if this beam of light is directed into the eyes of an approaching driver the glare is so intense that there is great danger in passing. If, then, it were not possible to so direct the rays of light that only the road were illuminated, a serious state of affairs would exist, and anyone using the highway at night would make himself highly objectionable and dangerous to all of the other users of the highway.

(Abstract will be concluded in June issue.)

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS .: PHILADELPHIA SECTION

H. P. LIVERSIDGE, Chairman

W. F. JAMES, Secretary, 1442 Widener Bldg.

ANNOUNCEMENT

REGULAR MONTHLY MEETING, Monday evening, May 14th, 1917, 8 o'clock, at the *Engineers' Club*. Subject: "MEASUREMENT OF TELEPHONE CURRENTS." Speaker: MR. H. MOURADIAN, Engineer of Transmission and Protection, Bell Telephone Company, of Pennsylvania, Philadelphia, Pa.

PAST MEETINGS

THE March and April meetings were well attended, there being about one hundred present on March 12 to hear Mr. Saul Dushman, of the Research Laboratory of the General Electric Company, explain, by means of many interesting experiments, "The Recent Developments in the Use of High Vacua," and the same number to greet Mr. Henry W. Fisher, Chief Electrical Engineer, Standard Underground Cable Company, who presented the subject, "Underground Cables: Their Manufacture and Use Under Modern Practice." The Section is indebted to both of these gentlemen for their courtesy in visiting Philadelphia and adding to the success of our 1917 meetings.

On March 8 the Joint Meeting with The Franklin Institute was held at the Hall of the Institute, and seventy-five members were present to hear Mr. C. E. Skinner, M.E., Engineer of Research Division, Westinghouse Electric and Manufacturing Company, East Pittsburgh, speak concerning "Dielectric Losses in Insulating Materials."

SPECIAL NOTICE

During April of each year it is the practice of the Philadelphia Section to send registration cards to all members of the Institute residing within fifty miles of Philadelphia, with a request that they sign and return same, signifying their interest in the affairs of the Section and their desire to receive all notices of meetings and other activities. These registration cards have been mailed and you are urged to return same immediately, so that our mailing lists may be brought up to date. If you have not received your card, please advise the Secretary and it will be sent at once. One of the most difficult duties of the Section Secretary is to keep the mailing lists accurate, and you can greatly assist by prompt registration and then immediately advising the Secretary of any change in address or failure to receive notices.

ANNUAL ELECTIONS

Nomination ballots will be mailed as soon as the registration is completed, and they will be followed in due course by the election ballots, so that at the Annual Dinner in June the new officers may be announced.

TECHNOLOGY CLUB OF PHILADELPHIA

H. A. TERRELL, President.

G. W. BARNWELL, Secretary,
33 Cooper St. Camden, N. J.

Coming Meetings: May 2. Dinner and Get-together Smoker. June 2. Annual Field Day at Woodbury.

APRIL MEETING

ON the evening of April 4 the regular monthly meeting of the Technology Club was held at the Engineers' Club. Dinner was served at 6:30, as usual. The speaker of the evening, Mr. P. E. Tillson, assistant engineer of the Bell Telephone Company, was unable to give his talk on "Telephone Engineering," as he has been called into the Federal service as a member of the Officers' Reserve Corps. His proxy, Mr. Dodge, who is

associated with Mr. Tillson in the telephone company, handled the subject ably. By means of an elaborate collection of lantern slides, showing in detail the many parts of a telephone system, and by making use of a working diagrammatic model, he was able to make very clear the different operations, as well as the engineering features in connection with telephony. As Mr. Dodge spoke extemporaneously, an outline of his talk is not procurable.

On such a subject, however, it would be difficult indeed to get much information without the slides and the working model. Suffice it to say that telephony, from a scientific and engineering standpoint, is a much more complex subject than the average man imagines.

ELECTION OF OFFICERS

The following officers were elected for the ensuing year:

H. A. Terrell, president.

P. E. Tillson, vice-president.

G. W. Barnwell, secretary.

Donald Frazier Waters, assistant secretary.

D. K. Bullens, C. J. Walton, H. L. Moody, E. P. Trask, E. E. Pierce, H. L. Walker, F. B. Barnes, Executive Committee.

Also the following appointments were made:

D. K. Bullens, Technology representative on Board of Directors of Engineers' Club.

H. A. Terrell, Technology representative on Meetings Committee.

H. L. Moody, Technology representative on the Public Relations Committee.

G. W. Barnwell, Associate Editor for M. I. T.

C. F. Willard and McGowan as a Membership Committee.

It was announced that Dr. Hollis Godfrey, president of Drexel Institute, will represent the Philadelphia Technology Club at the meetings of the "Technology Clubs Associated" in Cleveland, April 19, 20 and 21.

MAY MEETING

As the speaker for the May meeting, Mr. E. D. Forbes, will not be able to deliver his talk on "Radio Work," it has been decided by the Executive Committee to have the May meeting in the form of a Get-together Smoker, at which time several matters of interest to the Club will be discussed informally. Perhaps we will have a talk on some engineering subject by some member of the Club. Subject and speaker to be announced later.

ANNUAL FIELD DAY, JUNE 2

It is not too early to announce that the Annual Field Day will be held at the Woodbury Country Club on the afternoon and evening of June 2. The afternoon will be taken up with a base-ball game and various forms of field day stunts. Supper will be served, and dancing will take place in the Club-house in the evening. This being our only outing of the year, let's make it a memorable occasion. All members of the Tech. Club are urged at this time to reserve the day and invite friends to accompany us to Woodbury.

The Secretary is very anxious to obtain the correct mailing address (whether residence or business) of every Technology man in Philadelphia and environs. There are unquestionably many Tech. men in this vicinity who are denied the pleasure of meeting with us through a failure to receive proper notice of meetings, etc. A special effort will be made to bring the mailing list up to date. If you have moved, notify the Secretary. If you prefer to have the notice mailed to your office or business address, make the fact known. Do something!



AMERICAN SOCIETY OF MECHANICAL ENGINEERS .: PHILADELPHIA SECTION

EMMETT B. CARTER, Chairman.

W. R. JONES, Secretary, Eng. Dept., Univ. of Penn.



On March 27 there was held in the auditorium of the Engineers' Club, at 1317 Spruce Street, a very excellent joint meeting of the Society and the American Society of Heating and Ventilating Engineers. A very thorough and comprehensive paper was read by Mr. Walter J. Kline, of the American District Steam Heating Company, on "District Heating."

In all localities where the temperature falls for any appreciable time below 70° F. artificial heating must be resorted to. Steam heating is, for many reasons, most extensively used. Systems where a flat rate prevails have gradually given away to systems where the service was metered. The speaker pointed out that metering is the only fair way of payment for both producer and consumer. He cited cases where flat rate systems had been the cause of most striking wastes in heat.

In the heating of public places, distinction must be made in the temperature for various classes of buildings. Thus clubs require a higher temperature to be maintained than theaters and churches.

Much attention was given by the author in his paper on the subject of financing various systems. The paper will subsequently be published in full in the journal of the A. S. M. E.

On April 24 there was a most interesting meeting of the local section held in the Engineers' Club. Mr. Carter, who presided, announced that arrangements for the entertainment of Doctor Hollis, president of the Society, had been planned for a meeting this spring, but unfortunately Doctor Hollis could not attend and all plans had to be changed.

The speaker of the evening was Mr. D. Robert Yarnall, of the Yarnall-Waring Company. He spoke on "Recent Developments in the Flow Meter." A discussion by the members followed.

The Engineers' Club and A. S. M. E. can well be glad that Mr. Yarnall is one of their members. His splendid personality and untiring energy in local engineering affairs have made him known and liked among us all.

PROCEEDINGS OF THE ENGINEERS' CLUB OF PHILADELPHIA

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CONTENTS OF THIS ISSUE

	PAGE		PAGE
Committee on Meetings	Inside Front Cover	Positions Open and Positions Wanted	272
Announcement by J. C. WAGNER, Chairman		In Memoriam—Ambrose Edwin Lehman	273
Officers, Directors, Standing and Special Committees of Engineers' Club	256	The Engineers' Club of Today and Tomorrow	274
Committee on Papers	257	Presidential Address presented at Annual Meeting of the Club, May 15, 1917	
Announcement by LEWIS H. KENNEY, Chairman		By EMMETT B. CARTER	
Secretary's Notices	258	The Inception and Development of the Submarine Boat	279
Special Meeting of the Club, May 4, 1917		By JOHN P. HOLLAND, JR.	
Thirty-eighth Annual Meeting of the Club, May 15, 1917		Leather—Treatment and Manufacture	287
Regular Meeting Board of Directors, May 8, 1917		By DR. LLOYD BALDERSTON	
Special Meeting Board of Directors, May 15, 1917		American Institute of Electrical Engineers	294
Annual Report Board of Directors for the Fiscal Year April 1, 1916, to March 31, 1917		American Society of Heating and Ventilating Engineers	294
Committee on Membership	265	Technology Club of Philadelphia	295
D. ROBERT YARNALL, Chairman		American Society of Mechanical Engineers	296
Budget—Comparative Abstract for 1916-1917	265	Illuminating Engineering Society	297
Committee on Coöperation for National Defense	266	Macadam Roads	298
GEORGE R. HENDERSON, Chairman		Industrial Notes	299
The Weather Business	267		
By GEORGE S. BLISS			

Permission is given to reprint any paper after its date of presentation, provided proper credit is given

Contributions of all kinds on all topics of interest to the members of the Engineers' Club are cordially invited. All matter for publication, including advertising copy, must be in the hands of the Editor by the 15th of the month for the issue of the following month.

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ENGINEERS' CLUB OF PHILADELPHIA

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SECRETARY TO THE SECRETARY

S. M. SNEDEKER

COMMITTEE ON PAPERS

LEWIS H. KENNEY, CHAIRMAN

ANNOUNCEMENT

REGULAR MEETING, TUESDAY, JUNE 19, 1917, AT THE CLUB HOUSE

The Committee announced in the October Proceedings that arrangements for a series of meetings for Junior members were being made, and in the November Proceedings that a prize was offered for the best paper prepared by a Junior member. The rules governing the award of prize were published in that issue. The Committee decided that the paper at the June meeting of the Club should be presented by the Junior member who won the prize.

The Committee takes great pleasure in informing the membership that the paper of the evening will be

"Philadelphia Bridges, Past, Present and Future," by Mr. Wilmer Z. Kline.

The paper will be illustrated with lantern slides.

The Junior prize will be presented by President Carter.

The Junior prize will again be offered next year.

REQUEST FOR SUGGESTIONS

The Committee requests for the information and assistance of the incoming Committee that the membership express their desires on the subjects of papers for presentation before the Club next year, and state the names of the speakers. If the members will kindly do this, it will greatly aid the incoming Committee in preparing a program of papers which will be in accord with the wishes of the membership.

ADDRESS LETTERS TO COMMITTEE ON PAPERS

SECRETARY'S NOTICES

A REGULAR MEETING of the Club will be held Tuesday evening, June 19, 1917, at 8.15 o'clock, at the Club House.

The Junior Prize offered by the Board of Directors will be presented by PRESIDENT CARTER.

MR. WILMER Z. KLINE, winner of the prize, will present his paper, "PHILADELPHIA BRIDGES, PAST, PRESENT AND FUTURE."

The paper will be illustrated with lantern slides.

ROBERT H. FERNALD, *Secretary*.

ABSTRACT OF MINUTES OF THE SPECIAL MEETING OF THE CLUB

HELD FRIDAY, MAY 4, 1917, AT WITHERSPOON HALL

The meeting was called to order at 8.30 P.M. by President Carter. About 300 members and guests were in attendance.

The paper of the evening, "Japan and America in the World War," was presented by Dr. T. Iyenaga, Manager of the East and West News Bureau, New York.

A unanimous vote of thanks was extended the speaker.

The meeting adjourned at 10.30 P.M.

LEWIS H. KENNEY,
Secretary pro tem.

ABSTRACT OF MINUTES OF THE THIRTY-EIGHTH ANNUAL MEETING

HELD AT THE CLUB HOUSE, TUESDAY EVENING, MAY 15, 1917

The meeting was called to order by President Carter at 8.25 P.M. About 125 members and guests were in attendance. The minutes of the Business Meeting of April 15, as published in the PROCEEDINGS, were approved.

The Board of Directors elected, at its last meeting, the following to membership: 10 Active and 1 Junior.

The members were informed that the Annual Report of the Board of Directors would be published in the June PROCEEDINGS.

The final report of the Committee on Club Development, published in the May PROCEEDINGS, page 210, together with the following resolution prepared by the Board of Directors, was presented by Mr. S. M. Swaab:

"WHEREAS, The Board of Directors, having made report to the Engineers' Club of Philadelphia in a Business Meeting duly called that they have an option from the Girard Trust Company, trustee, for the purchase of the premises at 1315 Spruce Street for the sum of \$35,000, of which sum \$15,000 shall be paid in cash on or before sixty days after the date of the final agreement to purchase said premises, and of which sum a purchase money mortgage for \$20,000, payable at the expiration of five years, secured on said premises, bearing 5.4 per cent. interest, payable annually, shall be given; and

"WHEREAS, Said option for purchase having been duly submitted to the Club for its action thereon, and the same having been duly read and considered, it is, therefore,

"Resolved, First, that the said option is hereby ratified and approved for the purchase of the said real premises, No. 1315 Spruce Street, for the consideration and under the terms and conditions therein mentioned, and that the proper officers of the Club be, and they are, hereby authorized and directed to make the purchase of said premises for the Engineers' Club of Philadelphia, in accordance with the terms of the option, and to pay the moneys and to make, acknowledge, and deliver a purchase money mortgage as heretofore provided, upon delivery of a good and sufficient deed or other assurances of law to the Engineers' Club of Philadelphia, for the premises No. 1315 Spruce Street;

"Second, that for the purposes of raising sufficient money to pay the \$15,000 required for the purchase of said property, and to pay the costs and charges incident to and connected with the purchase, alteration, equipping, furnishing, and fitting up of the premises for Club purposes, the Board of Directors is hereby authorized and directed to borrow a sum not exceeding \$40,000, and to issue the Club's bonds at 5 per cent. interest, or the Club's notes at 4 per cent. interest, therefor, in such denominations and upon such terms and conditions as may be deemed meet and proper; and to issue life memberships in the Club to a number not exceeding twenty, at a cost of \$300 for each life membership; and

"The Board of Directors is hereby further authorized and empowered to execute and deliver to some person, persons, or company whom they may select as trustees for the holders of said bonds and notes a mortgage upon said property and its equipment and its furnishings, for the sum of \$40,000, said mortgage to be a second mortgage, and to contain all the covenants and conditions of like nature and kind under the laws of Pennsylvania.

"Third, that the Board of Directors be, and is, hereby given and vested by the Club with full power and authority in its name and behalf to do and perform all necessary acts and things to carry out the provisions of this resolu-

SECRETARY'S NOTICES

tion, and all and every matter and thing they shall do in said premises is hereby ratified and confirmed."

The report and resolution were discussed by Messrs. Hess, Yarnall, Parker, Shelley, H. M. Chance, T. M. Chance, Voynow, Gant, Hering, and Dallett.

It was moved and carried that it is the sense of this meeting that action on the report of the Committee on Club Development and the resolution presented by the Board of Directors be left to the discretion of the Board.

The annual address, "The Engineers' Club of Today and Tomorrow," was presented by the retiring president, Mr. Emmett B. Carter.

The Tellers presented the following report:

Mr. President and Members of

The Engineers' Club of Philadelphia.

GENTLEMEN:

Your Tellers have counted the ballots cast for the election of officers, and declare that 334 legal ballots were cast and the following officers elected:

Officers	Votes
For President	
(To serve until July 1, 1918),	
J. A. Vogleson	332
For Vice-president	
(To serve until July 1, 1920),	
William C. L. Eglin	333
For Treasurer	
(To serve until July 1, 1918),	
Jonathan Jones	334
For Directors-at-Large	
(To serve until July 1, 1918),	
R. H. Fernald	330
George R. Henderson	317

Respectfully submitted,

Tellers { GEO. E. CROFOOT,
 JOHN P. MUDD,
 JOHN S. ELY.

The President declared the nominees elected. Mr. J. A. Vogleson, the president-elect, was conducted to the platform by Mr. S. M. Swaab and presented to the membership. Mr. Vogleson, in accepting the office, expressed his appreciation of the honor conferred upon him, and assured the members that he would serve the Club to the best of his ability.

The meeting adjourned at 10 P.M.

ROBERT H. FERNALD,
Secretary.

REGULAR MEETING OF THE BOARD OF DIRECTORS

MAY 8, 1917

The meeting was called to order by President Carter at 7.25 P.M., with Vice-Presidents Vogleson, Yarnall, and Andrews, Directors Murray, Gibson, Crampton and Cassell, Past Presidents Taylor and Swaab, Secretary Fernald, and Treasurer Irish in attendance. Directors Wagner, Liversidge, and Bachman and Past Presi-

dent Ledoux were excused. Directors Temple and Bullens were absent.

No quorum was present for the transaction of business at the Regular Meeting of the Board, April 10. A Special Meeting was therefore called for April 17. The minutes of that meeting, as issued to the Board of Directors, were approved.

REPORT OF THE PRESIDENT

In accordance with authority granted at the last meeting of the Board of Directors, the following are appointed to represent the Club at the State College Elections for Directors, June 12, 1917:

J. H. M. Andrews
H. C. Heaton
William D. Polk

Mr. B. A. Haldeman has been appointed delegate to represent the Club at the National Conference on City Planning, May 7 to 9, 1917, to be held at Kansas City, Mo.

REPORT OF THE SECRETARY

In accordance with instructions of the Board, a reply has been prepared to the letter from the Society of Civil Engineers of Portugal, requesting information on fees allowed engineers for professional services.

The following members in good standing have tendered their resignations:

Fred E. Bright	Harry C. Kofke
E. H. Giles	Percival Roberts, Jr.
J. S. Kenyon	

Action: Referred to Committee on Increase of Membership.

The Worcester Tech. Club was elected to Affiliated Membership at the April Meeting of the Board. According to the By-laws, Article IV, Section 6, it is necessary for the Board to elect a Director-at-large.

Action: Matter referred to the incoming Board.

The Worcester Tech. Club has informed us of its officers and representatives on our Board and committees, as follows:

George A. Denny, Chairman.
Robert M. Barr, Secretary.
Representative on our Board of Directors, Robert M. Barr.
Representative on our Committee on Meetings, W. P. Dallett.
Representative on our Committee on Public Relations, George A. Denny.
Associate Editor, Club Proceedings, Robert M. Barr.

The following are the officers for the year 1917-1918 of the Eastern Pennsylvania Chapter of the American Society of Heating and Ventilating Engineers:

George W. Barr, President.
J. T. J. Mellon, Vice President.
George Boon, Secretary.
H. P. Gant, Treasurer.

ENGINEERS' CLUB OF PHILADELPHIA

Mr. Ralph E. Young, who resigned as a Junior member in good standing January 9, 1917, asks to be reinstated.

Action: Board reinstated Mr. Young as of April 1, 1917.

REPORT OF THE BUSINESS MANAGER

The annual report of the Board of Directors, including the auditors' report, was submitted.

Action: Report, exclusive of auditors' report, approved.

In my April report I recommended that a committee be appointed to consider the subject of increasing our affiliated society membership. This subject was referred to our Committee on Increase of Membership. It is submitted for consideration that this be made a separate committee, due to the fact that its work is entirely different from that of the Committee on Increase of Membership, the difference being that one committee would be interested in increase of individual membership and the other in increase of affiliated society membership.

Action: President authorized to appoint a committee of three on Increase of Affiliated Society Membership.

It is requested that the Board assign room No. 31 for an accounting department. At the present time the bookkeeping is done in the office below, where the records are accessible to any one who visits the office, and there is a constant series of interruptions due to telephone calls, cigar sales, etc., which seriously interferes with the work of keeping the books. We are arranging for a revision of the bookkeeping system, in order that we can better analyze receipts and expenditures. I am of the opinion that it is very desirable to separate the accounting office from the office below. If room No. 31 were assigned for the accounting department, it would considerably facilitate the transaction of Club office business. This subject I have discussed with the Chairman of the Committee on House, but he does not desire to assign the room for this purpose without formal approval of the Board. The previous Committee on House held a very similar view at the time I requested the assignment of room No. 33 for the Secretary's office, because the assignment of that room represented a loss in revenue to the Committee. The Committee, however, desired the formal approval of the Board, and the Board approved my request.

Action: Matter referred back to Mr. Kenney, suggesting the advisability of deferring same until the appointment of the Executive Secretary.

The membership of our affiliated societies is in accordance with the following tabulation:

ILLUMINATING ENGINEERING SOCIETY

176 members
7 members (in 2 societies)
1 member (in 3 societies)
1 member (in 4 societies)
75 members (in Engineers' Club)
94 members (outside 10-mile limit)

354

AMERICAN SOCIETY MECHANICAL ENGINEERS

182 members
15 members (in 2 societies)
2 members (in 3 societies)
1 member (in 4 societies)
178 members (in Engineers' Club)
89 members (outside 10-mile limit)

467

AMERICAN SOCIETY CIVIL ENGINEERS

23 members
1 member (in 4 societies)
86 members (in Engineers' Club)
12 members (outside 10-mile limit)

122

TECHNOLOGY CLUB OF PHILADELPHIA

23 members
4 members (in 2 societies)
1 member (in 4 societies)
16 members (in Engineers' Club)
15 members (outside 10-mile limit)

59

AMERICAN SOCIETY HEATING AND VENTILATING ENGINEERS

30 members
4 members (in 2 societies)
1 member (in 3 societies)
18 members (in Engineers' Club)
5 members (outside 10-mile limit)

58

SOCIETY OF AUTOMOBILE ENGINEERS

26 members
17 members (in Engineers' Club)
15 members (outside 10-mile limit)

58

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

145 members
11 members (in 2 societies)
2 members (in 3 societies)
111 members (in Engineers' Club)
91 members (outside 10-mile limit)

360

WORCESTER TECHNOLOGY CLUB

16 members
2 members (in 2 societies)
12 members (in Engineers' Club)
8 members (outside 10-mile limit)

38

1516 Total number of members

Sample of Club emblem has not been approved, but has been returned to the manufacturers. A new die is being prepared and will be submitted shortly.

Mr. Francis Head, Active Member, requests to be transferred to non-resident membership as of April 1, 1917, stating that he has been located in New York for several months. He also requests the withdrawal of his letter of resignation.

Action: Board granted request.

SECRETARY'S NOTICES

REPORT OF THE TREASURER

The Treasurer presented a report of the financial condition of the Club:

Action: Report accepted.

REPORT OF THE COMMITTEE ON FINANCE

The Committee recommended that the appropriation to the Committee on Meetings be transferred to the Committee on Papers.

Action: Board approved transfer.

REPORT OF THE COMMITTEE ON HOUSE

The Committee submitted no report.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The Committee presented a report, recommending that the following be elected:

Active:

A. Jules Betus	Lewis F. Moody
Samuel H. Cornell	Wm. F. O'Brien
John E. Dolbow	Clarence B. Rogers
Tom C. Mahady	Elmer P. Rust
Lawrence B. Manley	Robert C. Wheeler

Junior:

G. Lindsey MacGarrigle

Action: Recommendation approved.

REPORT OF THE COMMITTEE ON PUBLICATION

The Chairman announced that the PROCEEDINGS continues on a self-sustaining basis. Copy is in hand for the June, July, and August numbers.

REPORT OF THE COMMITTEE ON PUBLICITY

The Committee submitted no report.

REPORT OF THE COMMITTEE ON LIBRARY

The Committee submitted no report.

REPORT OF THE COMMITTEE ON PAPERS

The following papers have been submitted by Juniors in competition for the Junior prize offered by the Board of Directors:

"Present Worth Methods as Applied to Telephone Engineering Studies."

"Telephone Engineering—Traffic Department."

"Comprehensive City Planning."

"Layout of Machine Tools for Large Light Manufacturing Plant."

"Philadelphia Bridges — Past, Present, and Future."

"Present Status of Tests for the Wearing Surface of Sheet Asphalt Pavements, Vitrified Bricks, Granite Blocks, and Wood Blocks."

The following have kindly consented to serve as Committee to examine these papers and make recommendation for award of prize:

Joseph C. Wagner, Chairman
Jonathan Jones
W. M. Boehm

The Juniors are arranging for a dinner Monday evening, May 28, and it is expected that the announcement of the winner of the Junior prize can be made at this dinner.

Action: Report accepted.

REPORT OF THE COMMITTEE ON MEETINGS

The Committee submitted no report.

REPORTS OF SPECIAL COMMITTEES

The Special Committees on Public Relations, on By-laws, and on Club Development submitted no reports.

The meeting adjourned at 9.25 P.M.

ROBERT H. FERNALD,
Secretary.

SPECIAL MEETING OF THE BOARD OF DIRECTORS

MAY 15, 1917

The meeting was called to order at 7.25 P.M. by President Carter, with Vice-Presidents Yarnall and Andrews, Directors Murray, Wagner, Liversidge, Gibson, Crampton, and Cassell, Past Presidents Taylor, Swaab, and Ledoux, Secretary Fernald, and Treasurer Irish in attendance. Directors Temple, Bullens, and Bachman were absent. Vice-President Vogleson was excused.

The Secretary presented a resolution prepared by Mr. J. A. Vogleson on the subject of purchasing the property, 1315 Spruce Street, published on page 258.

A letter on the subject of Club development from Mr. Edwin S. Philips was presented and referred to the Committee on Club Development.

The report of the auditors was presented by Mr. J. F. Murray, chairman of the Committee on Finance.

Action: The Board accepted the report, which is published as a part of the Annual Report of the Board of Directors on page 263.

A letter from the Business Manager was presented on the subject of assigning room No. 31 for the accounting department.

Action: The House Committee was authorized to surrender room No. 31 for the purpose requested, if this should later be found advisable.

The meeting adjourned at 8.15 P.M.

ROBERT H. FERNALD,
Secretary.

ANNUAL REPORT OF THE BOARD OF DIRECTORS

FOR THE FISCAL YEAR APRIL 1, 1916, TO MARCH 31, 1917

The Board of Directors herewith submits its report for the period April 1, 1916, to March 31, 1917, as follows:

The summary of membership on March 31, 1917, as compared with the summary of March 31, 1916, is as follows:

ENGINEERS' CLUB OF PHILADELPHIA

	MARCH 31, 1916.			MARCH 31, 1917.		
Class	Resident	Non-Resident	Total	Resident	Non-Resident	Total
Honorary	3	3	6	3	3	6
Active	2038	238	2276	1987	265	2252
Junior	129	3	132	99	0	99
Affiliated	1	..	1	..	..	..
Army and Navy.	3	4	7	3	5	8
	<u>2174</u>	<u>248</u>	<u>2422</u>	<u>2092</u>	<u>273</u>	<u>2365</u>

Elected to membership during the year:

Active 135 Army and Navy..... 1
Junior 16

Resignations during the year:

Active 87 Junior 5

Applications withdrawn:

Active 26 Junior 1

Dropped from the rolls:

Active 72 Junior 3

Deaths:

Active 15

The record of deaths is:

ACTIVE MEMBERS.

Wm. C. Janney.....Died March 16, 1916.
Benjamin C. Pole.....Died April 27, 1916.
James C. Eckliff.....Died May 9, 1916.
F. L. Paddock.....Died May 13, 1916.
Merwyn R. Lewis Died May 10, 1916.
Edmund G. King.....Died August 24, 1916.
Otto C. Wolf.....Died December 19, 1916.
Theodore N. Ely.....Died October 28, 1916.
H. H. Hewitt.....Died August 31, 1916.
Wm. G. Ramsay.....Died September 28, 1916.
Wm. J. Bradley.....Died October 14, 1916.
Charles E. Hubsch.....Died January 27, 1917.
Edward J. Dimmick.....Died March 13, 1917.
A. W. MacCallum.....Died February 3, 1917.
John P. MacLearn.....Died February 24, 1917.

During the year affiliation with the local sections of the following societies has been accomplished, in accordance with the By-laws:

Society of Automobile Engineers.

American Society of Heating and Ventilating Engineers.

During the year the following meetings have been held:

Engineers' Club	20
A. S. C. E.....	4
A. S. M. E.....	4
A. I. E. E.....	8
I. E. S.....	9
Technology Club	9
S. A. E.....	9
A. S. II. and V. E.....	9

The maximum attendance at the meetings held at Witherspoon Hall was 1000.

The program of papers was prepared to develop coöperation with our Affiliated Societies by selecting non-

technical papers to be presented before the Club, whereas the Affiliated Societies selected technical subjects of specific interest to their membership. An exchange of invitations to meetings was made. The program was as follows:

1916

April 1—"Military Engineering," Col. George A. Zinn, U.S.A.

April 8—"Military Engineering," Col. George A. Zinn, U.S.A.

April 15—"Military Engineering," Col. George A. Zinn, U.S.A.

April 18—"The Naval Consulting Board," Howard E. Coffin.

April 29—"Military Engineering," Col. George A. Zinn, U.S.A.

May 6—"Practical Applications of Statically Indeterminate Constructions," W. H. Holtappel.

May 13—"Preparedness—the American Program," William I. Hull.

May 16—Annual Address, "Labor, Capital and Efficiency," J. W. Ledoux.

June 20—"Belt Pulleys," Charles A. Brinley.

September 19—"The Electrification of Steam Railroads," William H. Thompson.

October 18—"Latin America: Its Economic and Engineering Possibilities," John Barrett.

November 21—"Military Aeronautics," Major William Mitchell, U.S.A.

December 13—"Blackfeet Indians of the Glacier National Park," Laurence D. Kitchell.

December 19—"The Economics of Power Plants," Francis R. Weller.

1917

January 16—"Chemistry," Edgar Fahs Smith.

January 26—"The Zoning System," Edward M. Bassett and George B. Ford.

February 20—"Road Building," J. H. Squires.

March 20—"Hunting Big Game in Alaska with a Movie Gun," Howard W. DuBois.

MEETINGS FOR JUNIORS

1916

November 27—"Telephone Engineering," A. P. Godsho, A. L. Gracey, and J. H. Mahan.

1917

February 26—"Organization of the Bureau of Surveys," Wilmer Z. Kline, Samuel Mustin, and Malcolm Orr.

March 26—"Organization of the Bureau of Highways," J. B. Moran, H. I. Goldstein, and H. M. Packer.

Special consideration was given to the subject of meetings for our Junior members, and Dr. W. M. Boehm, of the Committee on Papers, was elected chairman of these meetings. Attendance at these meetings was limited to Junior members and their guests.

SECRETARY'S NOTICES

In order to stimulate the interest of the Juniors, a prize of fifty dollars was offered for the best paper on a technical subject. Rules governing the award of prize were published in the PROCEEDINGS.

The special meeting of January 26 on "The Zoning System" was the only paper arranged dealing with local municipal engineering problems.

The PROCEEDINGS of the Engineers' Club of Philadelphia has been extensively revised by combining the former PROCEEDINGS and the BULLETIN, by adopting 9 × 12 inches as the standard size, and by increasing its advertising value.

These changes were made in order to increase the value of the PROCEEDINGS to the membership. There are published in each issue an editorial, announcements by the various committees, minutes of the meetings of the Club and of the Board of Directors, papers presented before the Club, announcements of our Affiliated Societies, and any papers submitted to the Committee by Affiliated Societies. Articles of timely interest from sources other than those enumerated are published from time to time.

In order to develop coöperation with our Affiliated Societies, each was requested to appoint a member to serve as an Associate Editor of the PROCEEDINGS. These editors have provided for each issue of the PROCEEDINGS notices of coming meetings, as well as reports of their meetings, and occasionally they have submitted the manuscript of papers presented before their meetings.

The underlying thought of the affiliation movement was to centralize the engineering interests in Philadelphia, and arrange for the exchange of engineering information. The PROCEEDINGS is the only means for recording and exchanging technical information.

The PROCEEDINGS is, at the present time, on a self-supporting basis.

The By-laws of the Club have been completely revised, the principal change being to provide for the establishment of the office of Executive Secretary.

The patronage of the restaurant has increased, approximately, 100 per cent., the total number of meals served being 26,123.

The lodging accommodations are insufficient to meet the demand of our members.

The subject of Club-House extension has been given very careful consideration, and a report prepared for issue to the membership, to explain the proposed purchase of the property, 1315 Spruce Street, and the plan to adapt it to meet our requirements.

The Fortieth Anniversary Banquet was held on March 30, 1917, at the Bellevue-Stratford. The Toastmaster was Mr. John C. Trautwine, Jr. The following speeches were presented:

"Forty Years Ago," L. M. Haupt, First President, Engineers' Club.

"Club Development," S. M. Swaab, Past President, Engineers' Club.

"Franklin Institute," Walton Clark, President, Franklin Institute.

"Engineering Democracy," Ira N. Hollis, President, American Society of Mechanical Engineers.

"Philadelphia," E. J. Cattell, City Statistician.

The Committee on Finance has prepared a budget for the fiscal year, April 1, 1917, to March 31, 1918, as follows:

Committee on Finance (fixed charges).	\$7,170.20
Secretary's Office	12,595.00
Committee on—	
Library	400.00
Papers	1,017.00
Membership and Increase of Membership	100.00
Club Development	1,500.00
Publicity	100.00
House:	
House loss	4,200.00
Restaurant loss	1,600.00
Publication:	
Operating loss	2,968.00
	\$31,650.20

The report of the auditors is as follows:

ENGINEERS' CLUB OF PHILADELPHIA BALANCE SHEET AS AT MARCH 31, 1917

<i>Assets</i>			
<i>Current Assets:</i>			
Cash:			
In banks—			
Third National Bank.....	\$2,563.97		
Colonial Trust Company—			
Interest account	844.93		
On hand	142.33		
			\$3,551.23
Accounts receivable	\$8,679.09		
Less reserve to provide for doubtful accounts receivable	2,500.00		
			6,179.09
Inventory of supplies—			
Wines and liquors	195.54		
Restaurant provisions	168.38		
Cigars	323.03		
			686.95
Insurance—			
Perpetual on Club House..	1,603.80		
Furniture and fixtures	132.00		
			1,735.80
			\$12,153.07
<i>Fixed and Other Assets:</i>			
Real Estate—Building at 1317 Spruce Street	\$72,850.00		
Furniture and fixtures—house	\$9,597.95		
Furniture and fixtures—restaurant.	1,421.28		
Library	2,100.00		
			\$13,119.23
Less reserve to provide for depreciation	1,500.00	11,619.23	\$84,469.23

ENGINEERS' CLUB OF PHILADELPHIA

Sinking Fund for redemption of second mortgage bonds—			
Regular account	\$39.90		
Principal account	637.17		
Interest account	1,225.01	1,902.08	
Building fund notes—special fund	\$3,250.00		
Second mortgage bonds	200.00	3,450.00	89,821.31
Total			<u>\$101,974.38</u>

Liabilities

Current Liabilities:

Accounts payable—			
Merchandise	\$3,949.16		
Banquet Committee	760.41		
Employees' Christmas Fund	261.30		
Accrued interest—first mortgage	540.00	\$5,510.87	
Bills payable—building account		3,250.00	
Trustees for the Redemption Fund of second mortgage bonds		3,450.00	
First mortgage payable	\$40,000.00		
* Second mortgage bonds	25,250.00	65,250.00	
		\$77,460.87	
Accumulated Funds		24,513.51	
Total		<u>\$101,974.38</u>	

* In hands of trustees for the Redemption Fund of second mortgage bonds.

SCHEDULE "A"

STATEMENT OF

(1) Revenue Account

(2) Accumulated Funds

(1) Revenue Account for the Year Ended March 31, 1917

Dr.			Cr.
Badge purchases	\$76.00	Advertising directory	\$240.00
Billiard and pool purchases	80.00	Advertising proceedings	6,881.70
Bulletin publishing ..	1,338.47	Badge sales	169.25
Board meetings	9.00	Billiard and pool sales	625.38
Commission—increased membership	37.44	Bulletin advertising ..	1,226.25
Committee on House ..	1.95	Buffet luncheons	40.50
Committee on Papers ..	.50	Cigar sales	4,105.30
Club luncheons	85.00	Dues—Members	32,320.30
Cigar purchases	3,390.05	Dues—Affiliated Members	602.69
Committee on Publication	104.15	Discount	28.41
Directory publishing ..	537.05	Income tax	.87
Extraordinary expense	1,021.71	Initiation fees	1,265.00
Entertainment—Speakers' expense ..	123.20	Library fund	16.77
Fuel	849.53	Link belt eng. fund ..	3.35
Gas and electricity ..	1,294.44	Lodgings	3,541.57
House salaries and wages	2,757.29	Proceedings sales ...	348.20
House expenses	2,658.18	Rent—meeting room ..	406.75
House—meals of employees	1,477.95	Restaurant sales	14,703.79
Interest	958.85	Restaurant—meals of employees	4,640.00
Interest—second mortgage bonds ...	2,160.00	Telephone receipts ..	234.15
		Wine and liquor sales ..	2,034.48

Insurance—fire	\$51.00
Insurance—liability ..	97.94
Interest—first mortgage	540.00
Interest—Building Fund notes	70.60
Library expense	171.66
Manager's salary	1,650.00
Meetings, committee.	734.10
Office salary	4,476.73
Office expense	2,327.48
Office meals of employees	1,108.05
Proceedings publishing	11,054.83
Rent—Witherspoon Hall	150.00
Restaurant—salaries and wages	4,574.86
Restaurant—expense.	1,235.45
Restaurant—meals—employees	1,949.85
Restaurant—purchases	13,722.10
State tax—second mortgage bonds ...	100.00
Taxes and water rent	950.00
Telephone expenses ..	780.93
Wine purchases	1,466.44
Reserve for doubtful accounts receivable, dues and house charges of members	2,500.00
Reserve to provide for depreciation on furniture, fixtures, etc.	1,500.00
Gain for the period under review, carried to accumulated funds	3,261.93

\$73,434.71

\$73,434.71

(2) Accumulated Funds as at March 31, 1917

Sundry accounts payable contracted during previous fiscal year and charged to surplus account ...	\$701.16	Balance, as shown on balance sheet, carried down	24,513.51
			<u>\$25,214.67</u>
Balance—April 1, 1916 ..	\$21,952.74	Gain for the period reviewed, brought forward	3,261.93
			<u>\$25,214.67</u>
		Balance, brought down	\$24,513.51

Respectfully submitted,

THE BOARD OF DIRECTORS,

EMMETT B. CARTER, *President*,

R. H. FERNALD, *Secretary*.

Audited by

The United States Audit Company
per Duncan MacInnes, President,
Certified Public Accountant

COMMITTEE ON MEMBERSHIP

D. ROBERT YARNALL, CHAIRMAN

CANDIDATES FOR MEMBERSHIP

Members having knowledge of the candidates are invited to submit to the Committee on Membership before June 7 a confidential expression of opinion as to the eligibility of the candidates; all communications to be addressed, "Chairman of the Committee on Membership, Engineers' Club, Philadelphia," marked "Confidential."

All applications are on file at the Club and can be referred to by any member.

FOR ELECTION TO ACTIVE MEMBERSHIP

JOSEPH HAY AMIES

Secane, Delaware Co., Pa.

President, Amies Asphalt Company.

Proposed by R. Y. Filbert and Issachar Murray.

HAROLD S. BELL

Woodbury, N. J.

Chief Engineer, Bramell Point Works, Paulsboro, N. J.

Proposed by Alexander H. Holcombe and James S. Merritt.

WILLIAM BOYD

224 W. Johnson St., Phila., Pa.

Leading Draftsman, U. S. N., Bureau Construction and Repair.

Proposed by Frederick F. Kauffman, F. Jasperson and James Swan.

FORREST GEORGE BROWN

5926 Pine St., Phila., Pa.

Draftsman, Atlantic Refining Company.

Proposed by Charles B. Buerger and Lester M. Goldsmith.

ARTHUR CLAASSEN, JR.

P. O. Box 42, Fort Washington, Pa.

Textile Expert for E. F. Drew and Company, Incorporated.

Proposed by Theo. G. Lovegrove and J. Caccavajo.

JOSEPH GERARD CROSBY

1404 N. 62nd St., Phila., Pa.

Vice-president and General Manager, Whalen Crosby Electric Company.

Proposed by L. P. Kellogg and H. F. Sanville.

FRANKLIN TOWNSEND MORGAN

Moylan, Rose Valley, Pa.

Branch Manager for Hogan and Son, of New York.

Proposed by Lawrence P. Kellogg and Charles H. Storm.

LOUIS B. SMYSER

7140 Cresheim Road, Phila., Pa.

Special Representative Allen Compensating Axle Company.

Proposed by R. George Ward and A. P. Fisk.

WALTER WOOD

400 Chestnut Street, Philadelphia, Pa.

Member of firm of R. D. Wood & Co.

Proposed by Carl Hering and Lewis H. Kenney.

FOR ELECTION TO JUNIOR MEMBERSHIP

C. RUSSELL LAVERTY

5133 Parrish St., Phila., Pa.

Draftsman, Concrete Steel Company.

Proposed by C. E. Dale, Paul E. Sigmund, and J. J. Trelis, Jr.



BUDGET

COMPARATIVE ABSTRACT FOR 1916-1917

	April 1, 1916 to March 31, 1917	April 1, 1917 to March 31, 1918
Committee on Finance (fixed charges)...	\$9,982.21	\$7,170.20
Secretary's Office	8,702.00	12,595.00
Committee on—		
Library	190.00	400.00
Papers	1,030.00	1,017.00
Membership and Increase of Mem- bership	50.00	100.00
Club Development	500.00	1,500.00
Publicity .....	.....	100.00
House—		
House loss	3,500.00	4,200.00
Restaurant loss	2,500.00	1,600.00
Publication—		
Operating loss	1,875.00	2,968.00
Total	\$28,329.21	\$31,650.20

COMMITTEE ON COÖPERATION FOR NATIONAL DEFENSE

GEORGE R. HENDERSON, CHAIRMAN

MEMBERS OF ENGINEERS' CLUB WHO HAVE BEEN CALLED INTO SERVICE IN THE ARMY OR NAVY OF THE UNITED STATES AS OF MAY 21, 1917

NAME	RANK	CORPS	LOCATION
CACCAVAJO, JOS.	Captain	Engineers' Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
FULWEILER, J. E.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
HALL, W. A.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
HOLLENBACK, E. E.	Major	1st Pennsylvania Infantry, National Guard	Columbia, Pa.
LAWRENCE, G. E.	Lieutenant J.G.	Naval Coast Defense	Philadelphia Navy Yard
LAWSON, T. W.	Lieutenant	Naval Coast Defense	Philadelphia
MCCORD, J. B.	Captain	Ordnance Officers' Reserve	War Department, Washington, D. C.
MYERS, W. T.		Fort Niagara Officers' Training Camp	
NEWLIN, E. M.		Fort Niagara Officers' Training Camp	
NIXON-MILLER, W.	Captain	Engineers' Officers' Reserve	Fort Niagara, N. Y.
O'CONNOR, F. B.	Captain	Engineers' Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
WILD, H. J.	Captain	Engineers' Officers' Reserve	Fort Niagara, N. Y.
WILSON, L. B.	Private	Company I, 1st Pennsylvania Infantry	Rockville, Pa.
WORTH, J. G.	Captain	Quartermaster's Officers' Reserve	

REQUEST FOR INFORMATION

THE COMMITTEE REQUESTS THAT THE MEMBERS OF THE CLUB
INFORM THE COMMITTEE OF THEIR ADMISSION TO THE MILITARY OR
NAVAL SERVICE.

THE COMMITTEE WOULD ALSO BE PLEASED TO RECEIVE SUGGESTIONS
FROM THE MEMBERS WHO HAVE ENTERED THE SERVICE.

PLEASE ADDRESS COMMUNICATIONS TO THE COMMITTEE ON COÖPER-
ATION FOR NATIONAL DEFENSE.

THE WEATHER BUSINESS

By GEORGE S. BLISS*
METEOROLOGIST

THE duties of the U. S. Weather Bureau are three-fold: First, the forecasting of all atmospheric conditions and disturbances; second, recording the values of the several elements, and the collection, compilation, and publication of the data; third, studying the effects of weather conditions on the many and varied industries of the country and working out the problems that arise in that connection.

Meteorologists the world over recognize that the only consistent and logical basis for the making of weather forecasts lies in the taking of frequent atmospheric surveys over large areas. It is at present impossible for any other country to map quickly and thoroughly so large an area as the United States. The favorable conditions and complete facilities for such work in this country make it expedient to maintain a comprehensive weather service such as can be found in no other country in the world. The complete network of telegraph



GEORGE S. BLISS
METEOROLOGIST
U. S. WEATHER BUREAU

lines makes it possible to establish reporting stations wherever they are needed for the work, and the centralized management of such a vast system of lines favors an extremely rapid collection and distribution of the information. It is chiefly for these reasons that weather forecasting has reached its highest attainment in this country, and it is such facilities that enable us to collect and distribute the information in time to be of value.

The advantages of mapping large areas can readily be understood when we consider that storms from Texas or the upper Mississippi valley frequently spread over the middle Atlantic states within 24 to 36 hours. It will also be understood that the mapping of the British Isles could scarcely reveal changes much in advance of those

heralded by local signs, although the map data would afford the better basis for the estimating of values.

In the matter of weather studies, and in the application of their knowledge, thus gained, to their industries, some of the European countries have made remarkable progress, and are not to be outdone by our own country.

HISTORICAL SKETCHES

It is, of course, impracticable to give an extended discussion of the historical side of the subject in an article of this kind, and I have therefore selected a few landmarks from a chronological outline of the "History of Meteorology in the United States," as prepared by the late Cleveland Abbe.

"So far as known, the first regular record of the weather on the American Continent was kept by the Rev. John Campanius at the Swedes Fort, near Wilmington, Del., from 1644 to 1645, inclusive."

There are many old diary accounts of unusual conditions that impressed themselves upon their authors at the time, and these serve chiefly as interesting items for reading, inasmuch as they are not specific enough in most instances to afford a basis for comparison with extreme and unusual occurrences of later times. The next record of daily observations seems to have been kept at Boston at a much later date than that mentioned above.

"1729-1730. A regular weather record was kept at Boston, by Hon. Paul Dudley, Chief Justice of Massachusetts."

From this time on there were several series of records kept at various places that, on the whole, were sufficient to show that average conditions in those times were not materially different from those of recent years.

"1738-1750. Regular meteorological observations were made at Charleston, S. C., by Dr. John Lining. These included Fahrenheit and other thermometers, the barometer, and the hygroscope."

"1742-1778. Regular meteorological records were kept at Cambridge, Mass., by Prof. John Winthrop, of Harvard College. He used a Hawksbee thermometer until 1763, and then a Fahrenheit."

"1748. Meteorological records were kept by John Bartram at his botanical gardens on the Schuylkill, near Philadelphia."

"1750-1759. Dr. Chalmers, at Charleston, S. C., continued the records begun by Dr. Lining."

"1753-1755. Meteorological records were kept by Dr. Richard Brooke, near Baltimore, Md."

* Member Engineers' Club.

"1772-1777. Thomas Jefferson, at Monticello, Va., and James Madison, at Williamsburg, Va., maintained a series of contemporaneous observations and showed that the climatic peculiarities of those two places harmonized completely."

After the close of the Revolutionary War meteorological records became more common and plentiful in the Atlantic states, and in 1819 the Surgeon General of the U. S. Army established a system of observations at

dividual is that of Dr. Jesse C. Greene, of West Chester, Pa. He began his record in January, 1855, and has continued it to date.

The early development of the science of meteorology presents many interesting incidents. Abbe says that the first person to suspect the progressive movement of our storms as a whole was Benjamin Franklin. In September, 1743, while he was Postmaster General, at Philadelphia, he desired to observe an eclipse of the moon, but was prevented from doing so by a storm, commonly known as a "northeaster." He later learned from Boston that the eclipse was over an hour before the storm began. From this he reasoned that, although the wind was blowing from the northeast in Philadelphia at the time, the storm formation moved up as a whole from the south or southwest. He did not live to see his theory verified or proved.

The first person to accomplish anything worth while in meteorological research, and in the scientific classification of the meteorological knowledge of the times, seems to have been James P. Espy.

"1820. James P. Espy (born 1785, died 1860) left his position in the Academy in Cumberland, Md., becoming Professor of Languages at The Franklin Institute in Philadelphia, and began his lifelong work in meteorology."

"1830. Espy announced the cooling of ascending air by expansion. About this time he resigned from all his work as a teacher and devoted himself to lecturing on meteorology."

"1836. Espy secured the appointment, by the American Philosophical Society and The Franklin Institute, of a joint committee for the study of storms."

"1840. In August and September, Espy appeared before the British Association for the Advancement of Science at Glasgow and the Academy of Science at Paris to expound and defend his ideas as to the theory and cause of storms. A committee of the Paris Academy of Sciences reported favorably on his theory of storms."

"1842. Espy was appointed 'Meteorologist to the U. S. Government' by Congress and assigned to duty under the Surgeon General of the Army, and was so employed from August, 1842, to June 30, 1847."

William C. Redfield and Elias Loomis were also early pioneers in the development of the science and contributed much of value.

"1831. Redfield published the first of a long series of memoirs of importance on hurricanes as great revolving storms."

"1836. Elias Loomis compiled his memoir on 'The Storm of 1836,' the first of a long series of important memoirs."

"1841. Loomis published his map and study of the storm of December, 1836, in the *Transactions of the American Philosophical Society at Philadelphia*."

"1847. December 8, Joseph Henry submitted his program of Organization and Work for the Smithsonian Institution, including, first of all, a system for extended



A STANDARD SHELTER FOR THERMOMETERS THERMOGRAPH, AND TELE-THERMOSCOPE, ETC.

the army posts in all parts of the country. Many persons and institutions began records almost simultaneously with those of the army, and thus, from 1820 on, we have sufficient data for quite a critical study of climatic conditions.

The longest continuous record in the United States was begun in August, 1812, at New Bedford, Mass., by Samuel Rodman, and is still maintained by his descendants. The Pennsylvania Hospital at Philadelphia has kept a continuous record since 1824.

So far as known, the longest record by a single in-

meteorological observations for solving the problem of American storms. The Smithsonian Institution continued after this date a prominent factor in the development of meteorology in the United States."

"1854. Prof. Joseph Henry reported that the telegraph companies were furnishing the Smithsonian Institution with daily morning weather reports. He had suggested the custom, which became established, in accordance with which the first message each morning on opening any telegraph office was in answer to the salutation, 'Good morning, what is the weather?' Each local operator gave to his division superintendent and the local newspapers a statement of these weather reports, viz., temperature, wind, and weather, and all of them were telegraphed to the Smithsonian Institution, where they were exhibited on a large wall map, day after day, during the years 1854-1861. These reports were frequently used by Professor Henry to predict, or show the possibility of predicting, storms and weather, a matter that he frequently urged on Congress. Espy and Henry were the prime movers in all matters of storm prediction, both in this country and in Europe."

"1869. September 1. Telegraphic reports and 'Weather Probabilities' began under the auspices of the Cincinnati Chamber of Commerce; 'The Weather Bulletin of the Cincinnati Observatory' began, and maps and bulletins were also published in the daily papers of Cincinnati. In November of the same year Prof. Increase Allen Lapham and Hon. H. E. Paine, of the Milwaukee Board of Trade, united with William Hooper and John A. Gano, of the Cincinnati Chamber of Commerce, in securing a resolution by the National Board of Trade, then meeting in Richmond, Va., asking Congress to establish a storm-warning service for all lake ports and sea ports."

"1870. February 2. Mr. Armstrong, local manager of the Western Union Telegraph Company, added a manifold weather map to the previous manifold weather bulletin issued at Cincinnati; and these continued until November 10, 1870, when the daily weather map of the U. S. Signal Service began."

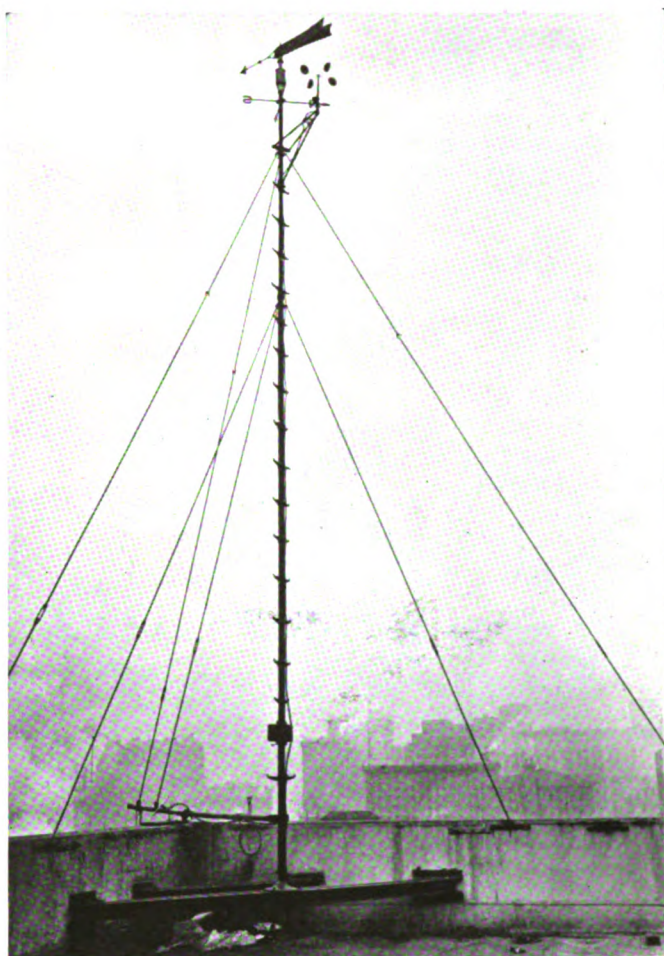
"1871. The regular published weather predictions began February 19, 1871; they were called 'Probabilities,' and were made three times daily for such elements and periods in advance as seemed warranted by the maps, and for eight geographical districts, viz., New England, Middle States, South Atlantic States, Lower Lakes, Upper Lakes, Eastern Gulf, Western Gulf, and the Northwest. Beginning with May, 1886, predictions have been made for states and parts of states instead of districts. Since July, 1888, the morning forecasts have been for periods 36 hours in advance, and beginning August 1, 1898, evening forecasts have been made regularly for periods 48 hours in advance."

"1890. October 1. The act transferring the meteorological work of the Signal Service to the Weather

Bureau of the Department of Agriculture was enacted. This act went into effect July 1, 1891."

WEATHER FORECASTING

There is an old saying that "Poets are born and not made," and the same sentiment can be applied quite appropriately to weather forecasters. The most profound students of atmospheric physics, or, in other words, the greatest meteorologists that the world has produced, were far from being the best forecasters. It is possible, of



STANDARD ANEMOMETER AND WIND VANE, CONNECTED WITH THE ANEMOGRAPH BY ELECTRIC CABLES. BY THIS MEANS EACH MILE OF WIND MOVEMENT IS RECORDED AS IT PASSES THE STATION, WHILE THE WIND DIRECTION IS RECORDED AT THE END OF EACH MINUTE.

course, to attain to a certain degree of proficiency in forecasting by a diligent study of the science of meteorology, but in order to excel in the profession one must possess a special faculty for intuitively and quickly weighing the forces indicated on the weather map and calculating the resultant. This special faculty is developed by long and continued study and association with the maps, rather than by a profound study of atmospheric physics, but it is impossible to develop it to the same degree in all individuals. It goes without saying that the forecaster must be a meteorologist. He must be so familiar with the underlying principles of the science that he can

readily comprehend the significance of the forces that he sees represented on the map, but it is not necessary that he should be able to work out complicated mathematical problems in the mechanics of the atmosphere.

One must pass a rigid civil service examination in meteorology, physics, and mathematics for admission to service in the Weather Bureau. It usually requires from five to seven years in actual service to develop the ability required for a local forecaster, while a considerable number are never able to qualify, and only about two



STORM-WARNING AND VESSEL-REPORTING STATION ON DELAWARE BREAKWATER, AT THE MOUTH OF DELAWARE BAY. THIS BREAKWATER HAS BEEN BUILT BY THE GOVERNMENT, TO FORM A HARBOR OF REFUGE FOR VESSELS IN TIMES OF STORMS. THE STEEL TOWER IS 85 FEET IN HEIGHT WITH A 35 FOOT FLAGSTAFF. FLAGS ARE DISPLAYED BY DAY AND LANTERNS BY NIGHT WHENEVER CONDITIONS ARE REGARDED AS DANGEROUS FOR COASTWISE VESSELS.

per cent. of those who enter the service are ever able to qualify as district forecasters. The difference in the requirements of the two grades is a matter of 4 or 5 per cent. in actual verification.

District forecasters are located at Washington, Chicago, New Orleans, Denver, San Francisco, and Portland, Ore. It is their duty to issue all storm, cold wave, and frost warnings, and to make daily forecasts of prevailing conditions for each state, such as are circulated by the Associated Press. The local forecaster is expected to study the local influences which sometimes cause different conditions than those prevailing for the state as a

whole. He must modify and amplify the forecast for his city and vicinity accordingly, and must include specific items, such as night minimum temperatures in winter, and other information when practicable. Sometimes he must differ with the district forecaster, and in this he is not restricted, except that the result of his efforts as a whole must be to improve the forecasts. Every published forecast is compared with the weather and temperature conditions that follow, and is made a matter of record in the Verifying Division of the Central Office in Washington.

The average success of all forecasts, for all seasons and for all parts of the country, is not far from 85 per cent. This high degree of accuracy is not generally realized, because many people receive their impressions of the service from the occasional failures that are brought to their notice. Again, when the average citizen is asked his opinion of the weather prospects for the day or night, he can only guess, because he has no information upon which to do otherwise. Unless he is a well-trained and thinking man, it is natural that he should conclude that all weather forecasts are mere guesses. The fact is that there are comparatively few things in which we can look into the immediate future with the assurance that obtains in weather forecasting.

The impression is largely prevalent that the making of the daily forecasts is the chief function of the Bureau, while in reality it is among the least valuable features of its work. The daily forecasts are constantly in the limelight, and they are the only portion of the work that reaches the whole people, but in the final analysis they are chiefly matters of convenience rather than of life or death or of the saving or loss of property. They are the most difficult part of the forecaster's work, for the reason that they are verified by the conditions that obtain during definite 12-hour periods, from 8.00 A.M. to 8.00 P.M. and from 8.00 P.M. to 8.00 A.M.

If a severe storm is moving up our Atlantic coast and warnings are ordered to be displayed from Jacksonville, Fla., to Eastport, Me., it matters not if the time of transition covers 36 hours or 48 hours, inasmuch as it is unsafe for vessels to leave port until it has passed. When a cold wave is sweeping across the country and warnings are distributed broadcast on its advance, it matters not if the lowest temperature at any particular place shall be reached in 24 hours or in 36 hours, inasmuch as perishable goods must be protected until a reaction to warmer has set in. Thus it will be understood that the really valuable part of the forecaster's work requires less precision in some respects than do the daily forecasts, in order to become wholly efficient and effective.

ACTIVITIES OF THE WEATHER BUREAU

If we were to express, in terms of dollars, the value of each of the several lines of the Bureau's work, their relative worth would probably come in the following order: Storm warnings; cold wave warnings; special

THE WEATHER BUSINESS

U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU
C. F. MARVIN, Chief.

U. S. DEPARTMENT OF AGRICULTURE,
WEATHER BUREAU
C. F. MARVIN, Chief.

PHILADELPHIA, PA.

Friday, February 9, 1917

SHIPPER'S CARD.

LOWEST TEMPERATURE LAST NIGHT.

PHILADELPHIA.....38°

Northerly Districts

Scranton, Pa.....36°
Albany, N. Y.....28°
Buffalo, N. Y.....10°

Westerly Districts

Pittsburgh, Pa. 10°
Cleveland, O.....10°
Columbus, O.....8°

Northeast along Coast

New York, N. Y.....36°
Hartford, Conn.....36°
Boston, Mass.....34°

South along Coast

Atlantic City, N. J....36°
Washington, D. C....36°
Norfolk, Va.....40°

Distant western and northwestern points as indicators.

Indianapolis, Ind.....0°
St. Louis, Mo.....8°
Kansas City, Mo.....8°
Chicago, Ill.....-2°
Des Moines, Iowa....-4°
St. Paul, Minn.....-14°
Duluth, Minn.....-18°
Bismarck, N. D.....-6°

ADVICE.

SHIPMENTS THAT WILL REACH THEIR DESTINATION IN 36 HOURS SHOULD BE PREPARED TO WITHSTAND TEMPERATURES AS FOLLOWS—

Northerly points.....5° to 10°
Westerly points.....5° to 10°
Northeast along the coast.....10° to 15°
South along the coast.....15° to 20°
Lowest for Philadelphia to-night.....15°

GEORGE S. BLISS.
Meteorologist.

SHIPPER'S CARDS FOR TWO SUCCESSIVE DATES DURING THE ADVANCE OF A COLD WAVE. IF THE ADVICE GIVEN ON THE FIRST CARD IS COMPARED WITH THE LOWEST TEMPERATURES FOR EACH DISTRICT AS GIVEN ON THE SECOND CARD THE EFFICIENCY OF THE ADVICE WILL BE SEEN. THIS INSTANCE ILLUSTRATES THE SERVICE FOR THE LAST COLD WAVE AT THE TIME THIS ARTICLE WAS WRITTEN. ON PREVIOUS OCCASIONS THIS WINTER THE ADVICE HAS BEEN MORE ACCURATE.

shipper's forecasts; climatological service; river and flood service; frost warnings; daily forecasts; crop service, and use of the records in court.

We cannot really calculate the value of the storm warnings, because we do not know what the losses would be in each instance if the warnings had not been displayed, for in these latter days severe storms do not sweep our coasts or our Great Lakes unheralded, in order to furnish examples. We can only estimate the probable results from those that obtained before the storm warning service was organized, when a single storm would sometimes claim more than a score of vessels, with their cargoes. Tropical storms are dangerous for vessels of all classes, but the large, high-power steamers are able to ride out almost any storm in northern latitudes, providing they are out on the open sea. The storm warnings

PHILADELPHIA, PA.

Saturday, February 10, 1917

SHIPPER'S CARD.

LOWEST TEMPERATURE LAST NIGHT.

PHILADELPHIA.....13°

Northerly Districts

Scranton, Pa.....2°
Albany, N. Y.....4°
Buffalo, N. Y.....-4°

Westerly Districts

Pittsburgh, Pa.....2°
Cleveland, O.....0°
Columbus, O.....0°

Northeast along Coast

New York, N. Y.....8°
Hartford, Conn.....6°
Boston, Mass.....10°

South along Coast

Atlantic City, N. J....14°
Washington, D. C....12°
Norfolk, Va.....16°

Distant western and northwestern points as indicators.

Indianapolis, Ind.....6°
St. Louis, Mo.....20°
Kansas City, Mo.....20°
Chicago, Ill.....0°
Des Moines, Iowa....6°
St. Paul, Minn.....-10°
Duluth, Minn.....-20°
Bismarck, N. D.....-14°

ADVICE.

SHIPMENTS THAT WILL REACH THEIR DESTINATION IN 36 HOURS SHOULD BE PREPARED TO WITHSTAND TEMPERATURES AS FOLLOWS—

Northerly points.....10° to 15°
Westerly points.....10° to 15°
Northeast along the coast.....10° to 15°
South along the coast.....15° to 20°
Lowest for Philadelphia to-night.....18°

GEORGE S. BLISS.
Meteorologist.

are therefore of chief value to the medium-sized and smaller vessels, such as are engaged in coastwise trade.

In the middle Atlantic states a whole winter season will sometimes pass without a severe cold wave, but in the middle West and the great central valleys they are of more frequent occurrence. A cold wave warning, when spread over the great central states, is followed by measures to protect immense quantities of perishable goods. A few thousands of dollars' worth in this town and a few thousands at another place mean that it runs into the millions when it is summed up for such a vast territory.

The special shipper's forecasts are of chief value in the larger cities where great quantities of perishable goods are prepared for shipment. They consist of advice regarding the temperatures that will be encountered by

shipments going out in various directions, in order that the goods may receive proper protection in the packing or that certain shipments may be held up a day or two as the conditions may require. Wherever this service has been properly administered it has resulted in saving about ten per cent. of all perishable goods handled during the winter season, and the losses have been comparatively unimportant. When one considers the millions of dollars' worth of goods that are handled in our large cities during a winter season it will be understood that a saving of ten per cent., which was formerly lost by freezing, represents a very large sum.

The climatological service consists of the collection, compilation, and publication of all of the weather records made in the whole country. They comprise not only the detailed records from the 200 regular Weather Bureau stations, but also the less comprehensive ones from something over 4500 coöperative stations. The latter stations are equipped with standard maximum and minimum thermometers and rain gauges, and daily readings of the instruments are made. There are one or more coöperative stations in nearly every county, and it will be seen that the climatological survey is very thorough and complete. These data have come to be used so largely that if the Bureau were to render no other service it would justify its existence at the present cost of maintenance, which is about \$1,700,000 per annum, or 1.7 cents per capita for the people of the United States.

The river and flood service furnishes daily gauge readings at many points on the larger streams, and at one or more places on each of the smaller rivers. For example, there are nine gauging stations on the Delaware and its tributaries, although it is an unimportant stream, from a flood service point of view. The daily forecasts of the river stages are valuable in some places in the movement of river traffic, while the flood warnings result in the saving of much movable property every year. In some places, such as the Ohio River below Cincinnati and the Mississippi below St. Louis, the movements of a flood can be calculated with mathematical precision. For example, it takes nearly four weeks for the crest of a flood to move from St. Louis to New Orleans, and yet as soon as it has passed St. Louis it is possible to forecast the stages that will be reached at the various gauges below to within from 0.2 to 0.4 foot, and to estimate the time of arrival of the crest of each place within from two to four hours. In the smaller streams and near the headwaters of the larger streams the work is much more complicated and much less accurate.

The frost warnings are becoming more and more valuable from year to year, as the farmers and fruit raisers are learning better and better how to take protective measures when the warnings are received. They are of chief value to orchardists and fruit raisers generally, and to truck growers in some parts of the country. The successful growing of cranberries is very largely dependent upon the frost warning service.

POSITIONS OPEN

Bureau of Yards and Docks, Navy Department, Washington, D. C., are in need of several first-class power plant designers; also a structural steel and reinforced concreting draftsman. Salary, \$125 to \$150 per month, depending on experience and ability. Apply to Mr. Francis R. Weller, Hibbs Building, Washington, D. C.

Draftsman wanted. Apply Engineers' Club, No. 148—A.

Young draftsman wanted immediately by manufacturers of power plant specialties. Must be technical graduate and have had shop experience. One familiar with feed-water heaters preferred. Exceptional opportunities to acquire knowledge of design and production. Rapid advancement. Apply Engineers' Club, No. 149—A.

Wanted.—Engineers experienced in construction work supervision. Apply Engineers' Club, No. 150—A.

POSITIONS WANTED

Mechanical engineer desires position. Apply Engineers' Club, No. 141.

Civil engineer with four years' varied railroad experience. Apply Engineers' Club, No. 143.

Mechanical Engineer—University of Pennsylvania, 1912. Several years' experience in shop, drawing-room, office and field. Prefers position outside drafting room. Personal interview. Best references. Apply Engineers' Club, No. 147.

Superintendent or General Foreman of construction work—bridges, grading, roadwork, etc. Apply Engineers' Club, No. 146.

Engineer absent from office most of the year wants to sub-rent one room of office suite in large office building, very centrally located. Party can have use of the entire office for the period the engineer is absent. Employs stenographer. A very attractive arrangement will be made with a responsible party. Apply Engineers' Club, No. 1—C.

IN MEMORIAM

THE decease, on April 5, 1917, of Ambrose Edwin Lehman marks the passing away of one who may be classed as one of the founders of the Engineers' Club of Philadelphia. He joined the Club February 2, 1878, in the first year of its life, less than two months after its organization on December 17, 1877.

He was born May 23, 1851, at Lebanon, Pa., and became a member of the corps of the Second Geological Survey of Pennsylvania in 1874, and continued his connection with the Survey for more than ten years, becoming experienced in topography, and especially in geologic topography. After completing the mapping of large areas in the South Mountains of York and Adams Counties, he went to Mexico as assistant chief engineer of the Interoceanic Railway, where he had charge of difficult location work in the districts between Vera Cruz and the City of Mexico. During the following years and up to 1891 he was chief engineer of the Gettysburg and Harrisburg Railroad during the periods of location and construction of that road, and later of the Brooklyn, Bath and Coney Island Railroad, and was consulting engineer in water-power development projects in North Carolina and Minnesota. During all this period and until his death he made Philadelphia his home and maintained his headquarters here, being occupied with a general consulting practice as civil and mining engineer. In the latter capacity he examined and reported on many mineral and mining properties, and in many cases had charge of the development of

such properties and the engineering work in connection therewith.

In the early years of his engineering life he won for himself a reputation for accurate and exact work. He was known as a keen observer and careful recorder of engineering and scientific facts. He noted in detail every observed fact, and this careful attention to details gave added value to all of his work.

He was a leader in certain branches of the technic of engineering surveying, devising and inventing methods for expediting and cheapening field work by the amplification of stadia measurements.

The high esteem in which he was held by his friends, by his clients, by the members of this Club, and by all who knew him well is a tribute accorded only to those whose character contains elements of sterling worth. He exhibited in the highest degree those qualities that engineers should emulate; he was steadfast, dependable, energetic, loyal, unbiased in judgment and progressive in spirit. He was

of kindly personality, genial, and considerate of others.

During the last few years of his life he was partly incapacitated and crippled by ill-health, but he continued his work, although laboring under enormous difficulty, giving us an example of magnificent courage in the face of almost insuperable obstacles.

In his death the Club loses one who steadfastly upheld the best aims and traditions of the profession, and its members lose a valued friend, who was a friend to all.



AMBROSE EDWIN LEHMAN

THE ENGINEERS' CLUB OF TODAY AND TOMORROW

PRESIDENTIAL ADDRESS, PRESENTED AT ANNUAL MEETING OF THE ENGINEERS' CLUB, MAY 15, 1917.

ONE year ago the Club honored me by electing me to the office of president, and, with the expiration of the term, it seems fitting to review briefly the activities of the Club during this period.

In some ways the past year has been a critical one for the Club. We had less than a year previous, by a most remarkable membership campaign, raised our membership by about 1800 new members. It was commonly believed that a large number of these men would resign before the end of the fiscal year. It was thought they had joined the Club because a friend had requested them to do so, and, having no particular interest, would not continue their membership. The year's history has shown that reasoning to be wrong. Almost as many new members have joined the Club as have resigned, showing that these men have found that the Engineers' Club really had something to offer them.

As one of our members so ably put it: "Engineers were not made to live alone." The great asset of membership in this Club is the association with the members, as no engineer, unless he is deaf, dumb, and blind, can frequent this Club without becoming a broader and a better engineer by so doing.

The Joint Committee on Engineering Education recently gave six qualifications for engineers:

Efficiency	Judgment
Understanding of Men	Knowledge of Fundamentals
Character	Technique

There are none of us possessing these qualifications to such a degree that we cannot add to those we possess by association with such men as frequent this Club.

It was the good fortune of the Club this year to have selected such able men to form our Board of Directors. To one unaccustomed to such an organization it would hardly seem necessary that once each month a dozen of these men should be required to work here until 11 o'clock at night discussing and deciding Club matters, besides the

numerous special committee meetings that are held. When your Board makes a recommendation, you need not worry about voting in favor of it.

Our great growth in membership brought with it many problems. Our house was much overcrowded. The dining-room was called upon to serve an average of one hundred meals per day. The rooms for the permanent or transient use of the members were inadequate. The rapid rise in the cost of food also added to the worries of Captain Andrews and his House Committee.

Increased facilities were necessary in order to properly accommodate our Affiliated Societies. Among these has been the lack of dining-room facilities. They frequently arrange for dinners previous to their meeting, and this is the natural place to hold such dinners. I think that every one on the Board thoroughly believes in the Affiliated Plan and the building up of a great engineering headquarters. From the Club standpoint, this brings us into association with able engineers who might not otherwise visit the Club. From the Affiliated Society standpoint (and as chairman of one of the Affiliated Societies I have had an opportunity to see), its advantages are that it gives the Affiliated Society a local headquarters for its mail, meetings, and committee meetings. Members of national societies repre-

sented by our Affiliated Societies are beginning to know that this is the Philadelphia headquarters of their society, and throughout the country this scheme of affiliation is becoming known as the "Philadelphia Plan" and is being commented upon very favorably.

In the course of our development a number of changes were necessary in the By-laws. Among the principal changes was the decision to establish the office of Executive Secretary, who would be in general charge of Club matters. Before the revision of the By-laws was completed, our popular business manager, Mr. Ritchie, resigned to accept a more lucrative position. The Board appointed a committee to select a business manager to



Photo. by Photo-Crafters

MR. EMMETT B. CARTER
PRESIDENT 1916-17

succeed Mr. Ritchie, and, after interviewing many candidates, they finally selected a man who, but a few days before he was to take charge, received a better offer to remain with his company. By this time it seemed probable that the new By-laws would be adopted, and it seemed wisest to wait until they were adopted before a definite appointment could be made by the new Board. The Committee then turned to Mr. Kenney, who, as secretary of the Club in 1916, was familiar with its affairs, and who, as the efficient chairman of the Committee on Papers, was frequently at the Club. They persuaded Mr. Kenney to assume the duties of business manager temporarily. Now, however, this matter is settled, as an Executive Secretary is about to be appointed.

You are all familiar with the PROCEEDINGS, which is published by our Committee on Publication; and, since you have elected the chairman of that committee for president next year, your indorsement of what he has accomplished is indicated. In his first report to the Board he stated that his Committee wished to place the Club before the public in a favorable and representative position befitting the dignity and purpose for which the Club was formed. He changed the size and character of the publication, and, although this presented a difficult financial problem, the Board had confidence in the ability of the Committee to satisfactorily solve this problem. The PROCEEDINGS to-day is a credit and a pleasure to the Club, and at the present time is on a self-sustaining basis.

During the last year the Club has been especially interested in matters of national defense. We have taken a parent's pride in Company "B" Engineers, N. G. Pa., since 1909, when it was mustered into the National Guard, and last summer, when the company was on the Mexican border, it was a great pleasure to hear from it and to send magazines and tobacco to the boys. We were highly gratified to learn that the War Department had commented so favorably upon the personnel and the work of the company. Our first contact with the Navy Department occurred last summer, when, in conference at the Navy Yard with one of the Commandant's staff, the question of naval reserve was discussed. The Navy Department was then considering the matter, and we tendered the services of the Club. They, however, wished us to wait until their plans were more fully developed. Early last fall the local Naval Consulting Board, of which Mr. Paul Spencer was chairman, requested the assistance of the Club in making an industrial inventory of the resources of the Philadelphia district. The business manager, Mr. Ritchie, and I examined the catalogue of members and selected certain members to whom a circular letter was sent requesting their assistance. About ninety per cent. of those appealed to volunteered their services.

When the international relations became more strained in the winter, a letter was written, in the name of the Club, to President Wilson, pledging our whole-hearted and loyal support in any emergency that might arise in his stand for the maintenance of the rights of the United States. His letter of thanks was followed by a letter from

the War Department, sending the details of Engineer Officers' Reserve Corps. This correspondence was published in the PROCEEDINGS for the information of the members.

On March 17, Mayor Smith invited attendance at a meeting to organize a Home Defense Committee, and later appointed an Enlistment Committee, on which you have been represented. As the work increased, a Committee on Coöperation for National Defense was appointed, with Mr. George R. Henderson as chairman. The Committee has held many meetings, and such men as Captain Bispham and Captain Bulmer, of the Navy Yard, and Major Pelot, of the Army, met with this Committee. The circular, which many of the members have filled out and placed on file at the Club, was prepared after we had been advised by these gentlemen. They will consult this index when the emergency arises, and any members who have not as yet filled out such forms should procure them from Mr. Henderson, and do so at the earliest possible date. Your Committee is in touch with all branches of the service, and if you want any information ask Mr. Henderson. All branches of the service are gradually enrolling members of the Engineers' Club; and when the war is over and it all becomes history, Philadelphia is going to be proud of the work of your Club.

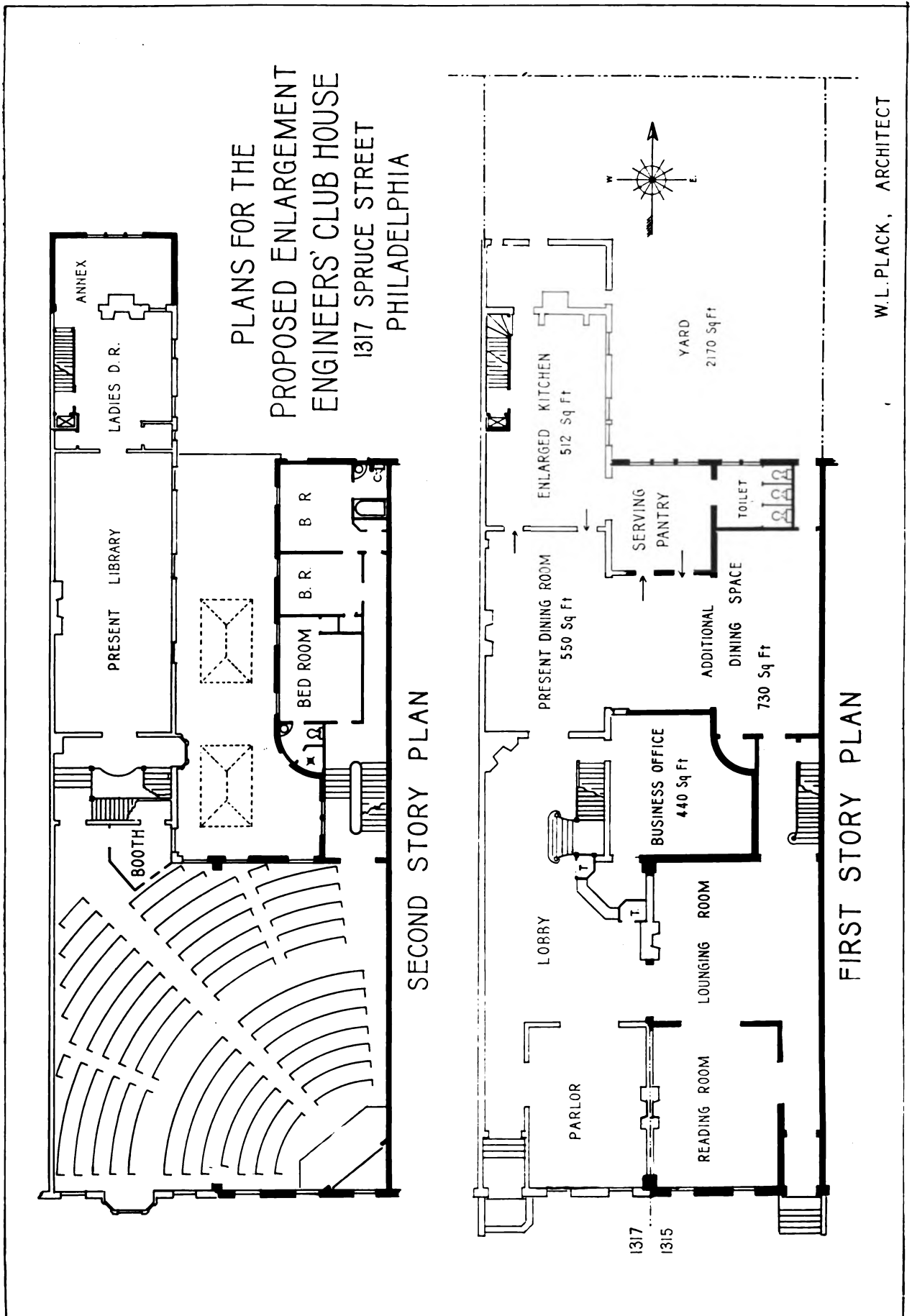
Now let us take another line of activity in which your officers have been interested—Club Development. Last summer the House Committee was asked to submit its ideas of what we needed. The main points of this report were: double the auditorium, double or treble the sleeping quarters. There is such a demand for the latter that the income from them will carry the increased cost of securing them. At the same time, the Finance Committee was asked to secure for us some data on the dues and property values of other clubs. From this latter report tables were prepared, which will appear later.

In October there was an interview with Dr. Walton Clark, of The Franklin Institute. In order to put this interview on record, a letter was written Doctor Clark, advising him that we were about to appoint a Club Development Committee, and after our talk we felt that, perhaps, a very satisfactory arrangement for both the Institute and ourselves would be one in which they would be located in adjoining buildings: The Franklin Institute to make available its scientific library and lecture-rooms, and the Engineers' Club to take care of the social features of the proposition. If this met with his approval, it was suggested that he select one of our members, who was also an Institute member, whom we would appoint on our Club Development Committee. Doctor Clark replied under date of November 24, saying that he was in sympathy with this idea, and he named Mr. Morton M. Price, who was appointed as a member of the Committee, of which Mr. Swaab became the hard-working chairman. The Committee consists of:

Mr. S. M. Swaab, chairman.

Mr. J. H. M. Andrews, of House Committee.

Mr. J. F. Murray, of Finance Committee.



THE ENGINEERS' CLUB OF TODAY AND TOMORROW

Mr. W. L. Plack, as architect.

Mr. M. M. Price, representing The Franklin Institute.

Mr. Swaab's speech at the banquet, and as published in the April PROCEEDINGS, under the title of "Vim, Vigor, and Victory," outlines their finding, which resulted in a proposed development composed of three stages: First, enlarging the second-story dining-room at a cost of \$800, which work is now about finished and which will be paid for out of operating expenses; second, the purchase of the property next door, which I will go into further; third, a modern Club House, to be built, perhaps, in five to ten years from now, and possibly on the Parkway, close by The Franklin Institute.

With the situation generally reviewed, let us take up our immediate problem: Step No. 2—The development of the property next door and the financial side of the problem. The following tables will cover this subject:

APPROPRIATION SCHEDULE

April 1, 1917, to March 31, 1918

Recommended by Committee on Finance, March, 1917

Committee on Finance (fixed charges)	\$7,170.20
Secretary's and Treasurer's Office	12,595.20
Committee on Library	400.00
Committee on Papers	1,017.00
Committee on Membership and Increase of Membership	100.00
Committee on Club Development	1,500.00
Committee on Publicity	100.00
Committee on House—	
House loss	4,200.00
Restaurant loss	1,600.00
Committee on Publication—	
Operating loss	2,968.00
	\$31,650.20

ESTIMATED INCOME

For the fiscal year April 1, 1917, to March 31, 1918

Dues—		
1992 Active Members	at \$15.00	\$29,880.00
3 Active and Non-resident	15.00	45.00
237 Active Non-resident		
135 Junior Resident	10.00	3,750.00
3 Junior Non-resident		
Initiation Fees	25.00	3,000.00
Affiliated Societies		800.00
		37,475.00
Less 10 per cent. for resignations, deaths, etc..		3,747.50
		\$33,727.50

It is evident, from the financial statements, that by the careful supervision of the Chairman and members of the various committees to which appropriations have been made they will be able to keep within the total amount available for the use of their committees, although the margin is so slight that practically all the income of the Club for the fiscal year will be required to meet the fixed charges and expenses incident to the various activities of the Club. Unless war conditions make matters more severe, there is no doubt that careful supervision and rigid economy will enable the Club to retain its present accommodations and exercise its present activities without any addition to the annual dues.

But if the Club is to enlarge its house and extend its various activities, then additional money is absolutely necessary; and, in the opinion of your Board, the proper method of securing this money is to tax those who directly benefit, by increasing the annual dues of our members.

CLUBS OF AMERICA, THEIR "FINANCIAL BASIS"

Club	Number of members	Annual dues	Cost of Club House	Method of financing
The Baltimore Club...	400	\$75	\$160,000	\$90,000 mtg. 60,000 certificate of indebtedness. 10,000 cash.
Chicago University Club	1800	80	1,100,000	Stock subscribed by members.
Cleveland Athletic Club	200	65	600,000	\$150,000 1st mtg. 100,000 2nd mtg. 200,000 pfd. \$500,000 1st mtg. 600,000 2nd mtg.
Detroit Athletic Club.	2300	80	1,500,000	
Detroit Engineering Society	740	12	Rented	
Brooklyn Engineers' Club	382	12	30,000	\$12,000 debenture bonds.
New York Athletic Club	3500	60	650,000	\$300,000 bonds. 350,000 1st mtg.
Pittsburgh Duquesne Club	1400	100	No information	No information
Pittsburgh Athletic Club	1996	60	1,230,000	\$800,000 1st mtg. bonds.
St. Louis Engineers' Club	556	10	Rented	
Washington-Columbia Cricket Club	650	65	70,000	Stock subscribed by members.
Washington University Club	910	50	320,000	No information.
Chicago Athletic Club.	2550	80	2,000,000	\$450,000 bonds.
Cleveland University Club	525	50	200,000 approx.	1st mtg. prf. stock to members.
Louisiana Engineering Society	260	10	Rented	
Pittsburgh University Club	592	60	119,500	5 per cent. 1st mtg. bonds to members.
City Club of Philadelphia	1600	30	285,000	\$100,000 mtg. bonds.
Philadelphia University Club	60			
New York Engineers' Club	1178	75	1,150,000	\$300,000 mtg.
Art Club, Philadelphia.	507	100	450,000	\$200,000 mtg.

EFFECT OF INCREASED DUES AND DECREASING MEMBERSHIP

1					
Members	Yearly dues	Income	Increase in income	Decrease in membership Per cent.	Number
2,000	\$15.00	\$30,000	.....	..	...
2,000	20.00	40,000	\$10,000	..	...
1,800	20.00	36,000	6,000	10	200
1,600	20.00	32,000	2,000	20	400
1,500	20.00	30,000	.....	25	500
2					
Members	Yearly dues	Income	Increase in income	Decrease in membership Per cent.	Number
2,000	\$15.00	\$30,000	.....	..	...
2,000	25.00	50,000	\$20,000	..	...
1,800	25.00	45,000	15,000	10	200
1,600	25.00	40,000	10,000	20	400
1,400	25.00	35,000	5,000	30	600
1,200	25.00	30,000	.....	40	800

ENGINEERS' CLUB OF PHILADELPHIA

TENTATIVE FINANCIAL PROGRAM

As presented by the Committee on Club Development.

1st—Issue 1000 shares stock or notes at \$25.00; guaranteed interest at 4 per cent.	\$25,000.00
2nd—Issue 5 per cent. bonds on 1315 and 1317 Spruce St., and additions and betterments.	15,000.00
3rd—Issue Life Memberships, 20 @ \$300.00.	6,000.00
Total amount authorized	\$46,000.00
First payment on 1315 Spruce Street to be made from stock sales	\$15,000.00
Alterations (estimated)	18,000.00
Furnishings (estimated)	5,000.00
	\$38,000.00
Surplus	8,000.00
	\$46,000.00

ANNUAL CHARGES.

Stock dividends 4 per cent. on \$25,000	\$1,000.00
Interest on bonds 5 per cent. on \$15,000	750.00
Interest on first mortgage \$23,000 @ 5.4 per cent.	1,242.00
Taxes, 1315 Spruce Street, \$35,000 @ \$1.75	612.50
Water Rent, 1315 Spruce Street	100.00
	\$3,704.50

To meet the annual charges will in itself require a nominal increase in dues, but to provide for the ordinary upkeep and for sinking fund charges and to retire the bonds at maturity will probably require say \$5000 per annum, which can readily be carried by \$20 dues. This is, in the judgment of our Committee, the minimum increase in dues which will allow us to put through the scheme which we have under consideration. This does not take into consideration any additional operating charges, as these can probably come from revenue derived from lodgings, etc.

1st—Sell stock or notes in excess of \$15,000.	\$15,000.00
2nd—Issue bonds to cover investment in 1315 Spruce Street	15,000.00
3rd—Sell balance of stock or notes	10,000.00
4th—Issue Life Memberships	6,000.00
	\$46,000.00

We can proceed with items 1, 3 and 4 simultaneously. Item 2 can only be prosecuted after at least \$15,000 has been secured under items 1 and 3.

During the war period the price of everything is increasing, and it will be serious to undertake a club development on too narrow a margin. I recommend, therefore, that you decide upon the \$25 dues, \$12.50 payable every six months, to take effect April 1, 1918; also that you instruct your Board of Directors to proceed at once with the financing and purchase of the next-door property. This will be the second step in our development plan. Some of you may raise the question as to why we do not at once undertake the third step, or the Modern Club now, instead of temporizing. First, a war period is not an opportune time to undertake a big funding program; secondly, it costs too much to undertake it without a club surplus to start. It will probably cost from \$200,000 to \$250,000. The Franklin Institute now has a surplus of over \$100,000, and it will probably not start its building until it has over a half million. Every few years some one dies and leaves a neat sum to the Institute. We hope that our members are going to have the same feeling toward the good work the Engineers' Club is doing. In these uncertain times every man should make a will. Some of the young Englishmen who went to the front took the matter of their wills as a joke. From now on, when the Philadelphia engineer writes his will, I hope he is going to keep in mind the vision of a future Club which will be an inspiration and help to the young engineer and a comfort to the old ones.

"And departing leave behind us
Footprints in the sands of time."



THE INCEPTION AND DEVELOPMENT OF THE SUBMARINE BOAT *

BY JOHN P. HOLLAND, Jr.

ILLUSTRATIONS COURTESY OF THE JOURNAL OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

I AM sorry to announce in opening that we will have to disappoint you somewhat this evening. A reel of moving pictures, showing the salvaging of the U. S. Submarine E-4 in Honolulu, has not arrived. It will be necessary for me to eliminate most of the technical detail.

The history of submarines extends over a period of three centuries or longer. It is one long series of failures, with here and there a few meagre successes, up to the time my father turned out his first successful submarine boat in 1877. It is difficult to tell who invented the first submarine. The first boat of which history makes any record was built by a Dutchman named Van Driebel, in 1640—twenty years after the Pilgrims landed in New England. This boat was built in England, with money advanced by King James I. She had a rather unique ballasting system. There were a number of goatskin bags placed under the deck, between two large planks. These bags, when filled with water, caused the boat to sink. To cause the boat to rise the two planks were pressed together with a windlass arrangement, forcing the water out, which gave the boat reserve buoyancy. It is said that on one occasion King James was taken for a trip from London Bridge to a point about a mile down stream submerged in this boat. We do not know, however, what eventually became of her.

The first submarine that attained any measure of success was built by David Bushnell, in Connecticut, during the American Revolution. Money was supplied by the state of Maine. The submarine was tested on Long Island Sound. It was a small boat, built to accommodate only one man, and was called the *Turtle*, owing to her peculiar shape. Her ballast tank was beneath the floor, and she carried a detachable lead keel to give reserve buoyancy in case of trouble. The inlet valve was beneath the operator's foot, and the water was expelled from the ballast tank by a hand-pump. The boat was propelled by a screw propeller, turned by a hand-crank. Above the operator's head was a screw which was to be used for attaching a torpedo to the bottom of the boat attacked. When the torpedo was secured by this screw to the bottom of the boat the submarine made its escape. A time fuse attached to the torpedo would operate after the submarine had gotten clear. After testing the boat on Long Island Sound, Bushnell found that he could successfully blow up a ship in this manner.

Bushnell, not being very strong, prevailed upon Sergeant Lee, of the Continental Army, to attack the British

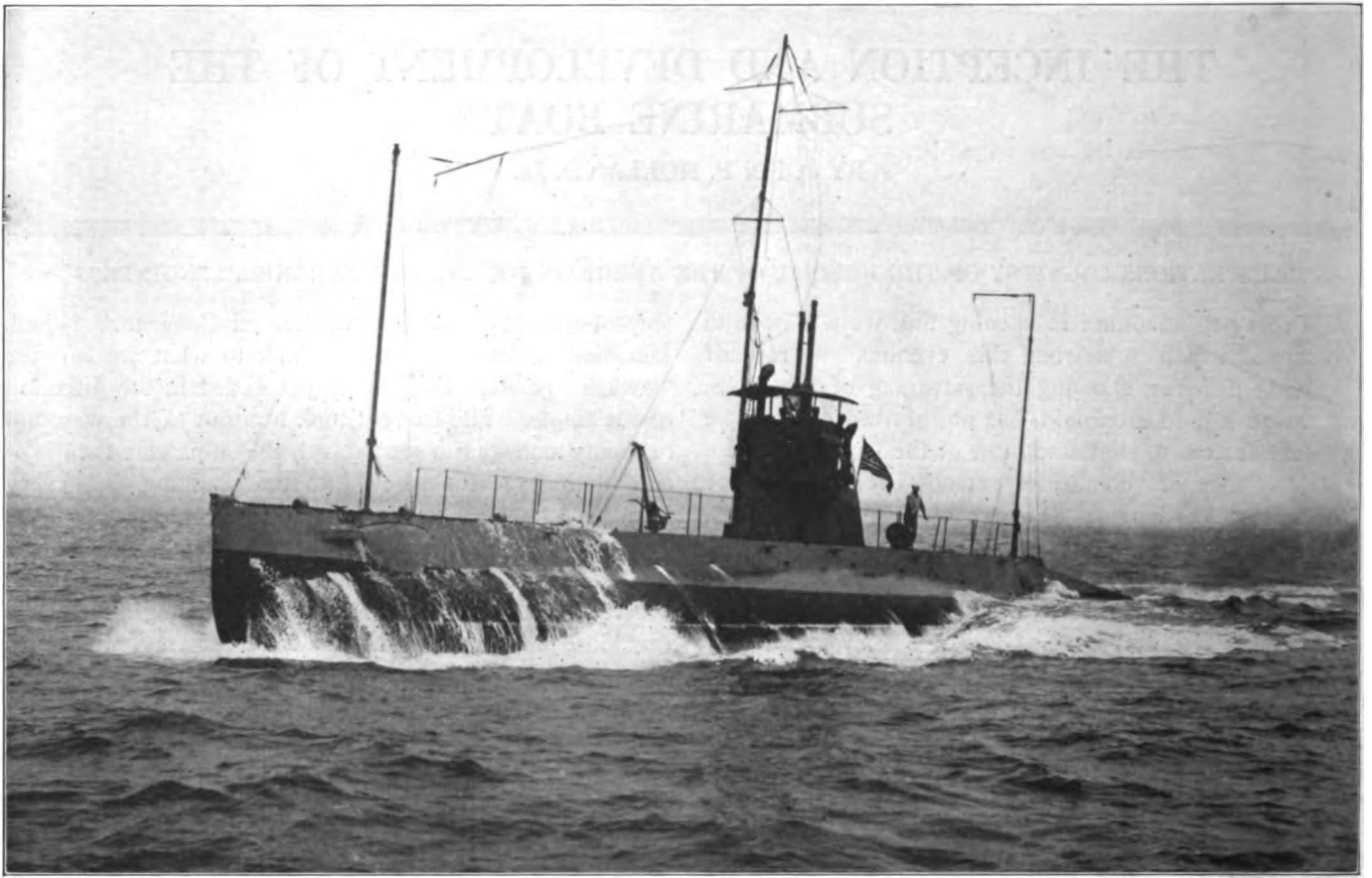
ship-of-war *Eagle*, then at anchor off Governor's Island. He filled his ballast tank and sank to what we call the "awash" position and slowly proceeded in the direction of the *Eagle*. The current took him out of the way, but he finally managed to get beneath the ship. He then proceeded to drive the screw into the planking, but every time he attempted it the submarine would back away, because he had not sufficient reserve buoyancy. Had he remembered to cast loose his lead keel he would have overcome that difficulty. Breathing becoming difficult, he cast loose his torpedo and made his escape. A short time afterward the torpedo blew up, but it had drifted too far from the ship to do any harm.

Next we have Robert Fulton's submarine boat, built in 1801. He tried to obtain money in this country to further his ideas, but met with no success. He went to France, where a company was organized and financed by the French Government. Agreement was made to the effect that for every English ship Fulton should destroy his company would receive a certain royalty, the amount of the royalty depending upon the size of the ship and the number of guns she carried. Fulton's boat was the same in principle as Bushnell's. The shape of the hull, however, was different. On the surface, instead of being propelled by a screw propeller, she had a collapsible mast and sail. The French Government soon lost interest in the submarine, however, when Fulton did not go out to destroy the English fleet lying outside Toulon Harbor. Becoming discouraged, Fulton went to England, but the English Admiralty, while they admitted that it was a good idea and might be useful to some nations, stated it would be absolutely of no use to the English Navy. He finally came back to America, where he devoted his time and energy in the development of the steamboat. Before his death Fulton started work on another submarine, the *Mute*, but his death cut short the work, and it was never completed.

The first German submarine boat, on her trial trip in 1850, collapsed in the harbor of Kiel. It was not built strong enough to withstand the water pressure at the depth the pilot tried to navigate. However, he managed to get the conning tower open and to come to the surface alive. The boat was raised in 1887, and is now in the Museum of Oceanography in Berlin.

The Phillips boat, built on Lake Erie in 1851, was the forerunner of Simon Lake's boat. His boat was designed with wheels to run on the bottom, and was intended for salvage purposes. The boat was propelled by steam and

* Presented at meeting of Engineers' Club, April 17, 1917.

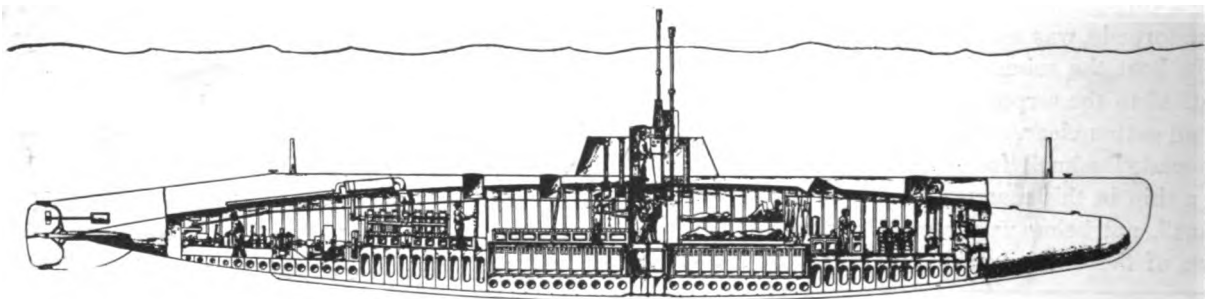


U. S. SUBMARINE K-1, JUST SUBMERGED. THE WIRELESS IS LOWERED FOR SUBMERGED WORK

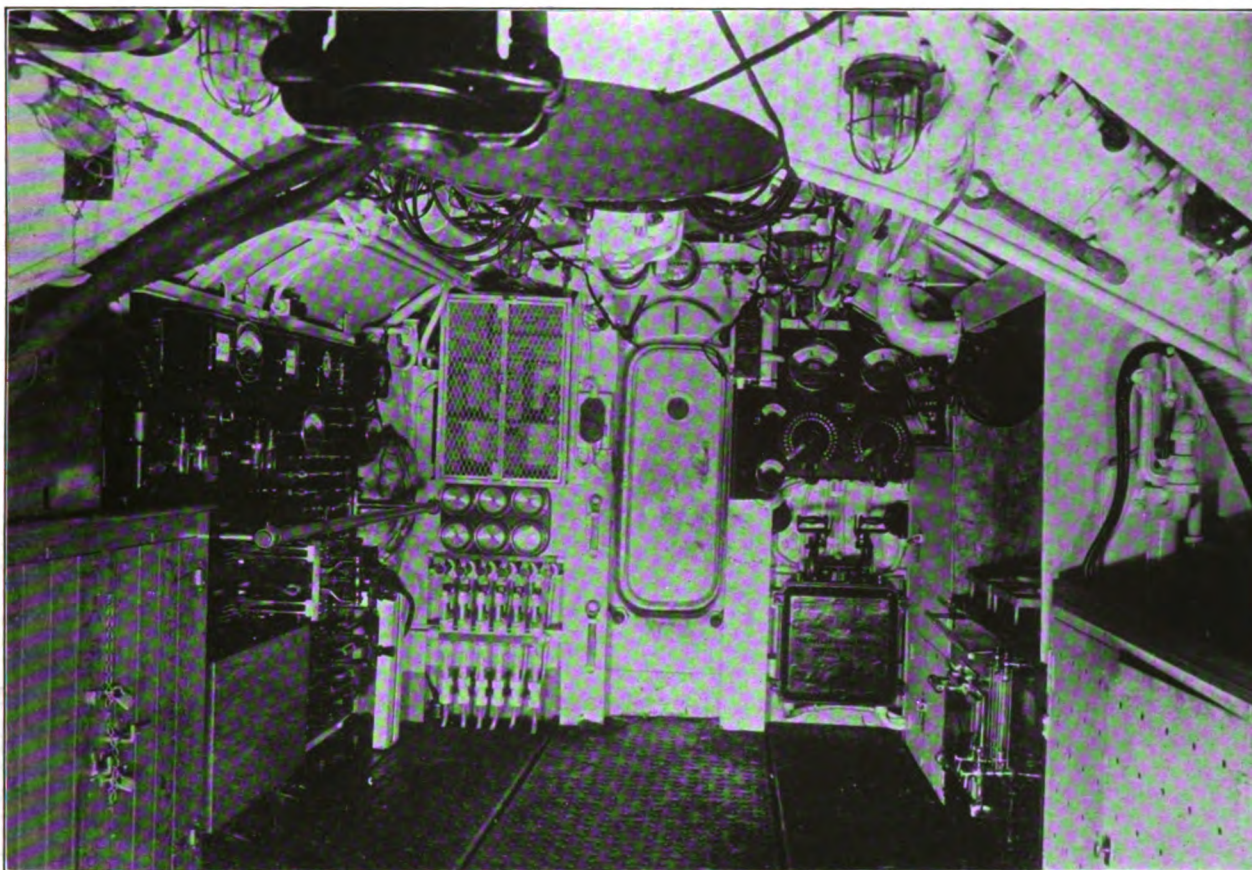
was fairly successful, but it had a shifting center of gravity, and on that account it was finally abandoned.

The Confederate submarine boat, the *Hurley*, was the first submarine up to the time of the Russo-Japanese War that ever destroyed a battleship. It was constructed of boiler iron, and had a crew of eight men. Her ballasting system was the same as used by Bushnell. A crank-shaft ran the length of the boat, and the crew turned it and thus propelled the boat. There was an officer stationed in each conning tower—fore and aft. Upon the first attempt to dive this boat was lost with her whole crew. The boat was in an awash position and had not left the dock when an excursion boat passed setting up a wash which passed through an open hatch and flooded the boat. The boat was later raised and equipped with a torpedo—a boom carried forward, on the end of which was a small contact mine. The mine was to be exploded against the

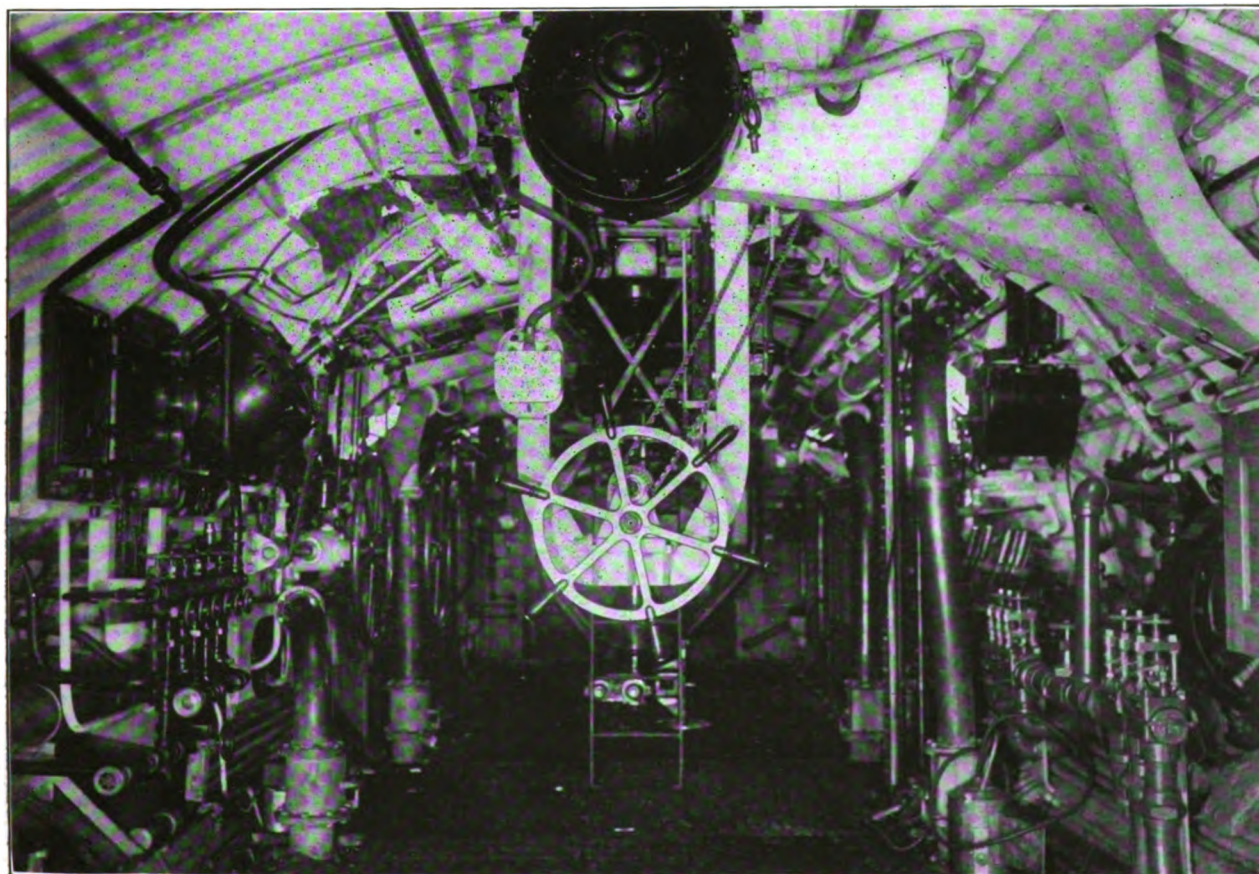
side of the ship attacked. Unfortunately on one of their trials they became entangled with some growth on the bottom, and the man-power of the propeller was not sufficient to back the boat out. When they found the boat at the end of a week, of course the men were all dead. Later another test was made, but the lieutenant in the forward conning tower stumbled and knocked the diving rudder control, causing the boat to suddenly dive while the conning tower was open, and all hands again perished. Finally, on February 17, 1863, Lieutenant Dickson, of the Confederate Navy, decided to attack with this boat the *Housatonic*, Union sloop-of-war, then blockading Charleston Harbor. He started out with eight men, and they got within a couple of hundred feet before they were discovered, when the sentry gave the alarm and fired at the boat. It was too close then to sheer her off, and a couple of seconds later the torpedo exploded against the *Housa-*



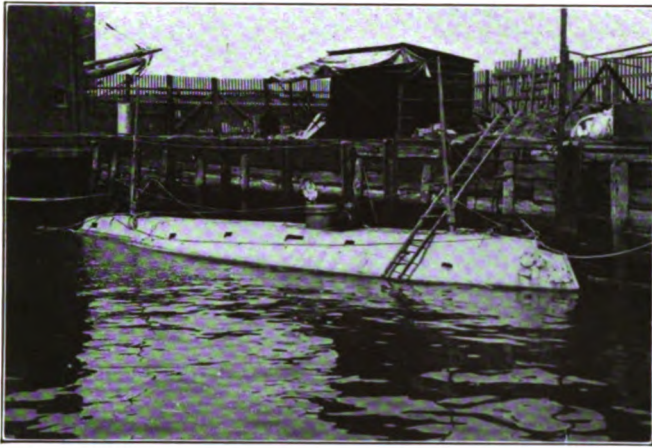
CROSS-SECTION OF A MODERN SUBMARINE



AFTER END OF CENTRAL OPERATING COMPARTMENT



FROM AMIDSHIPS LOOKING FORWARD



U. S. SUBMARINE HOLLAND



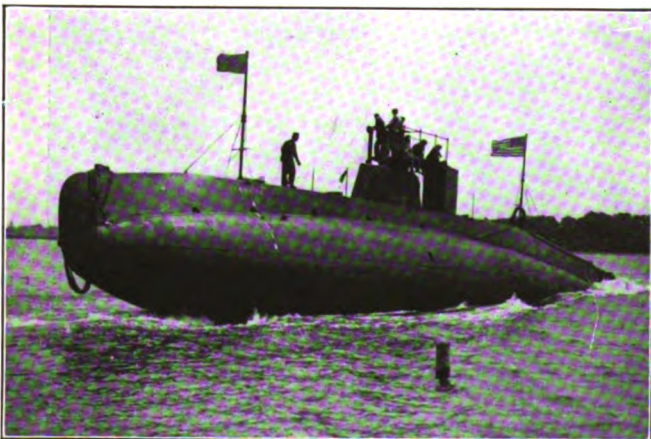
U. S. SUBMARINE M-1

tonic and she went down. The *Hunley* went down also, because her hatchway was open.

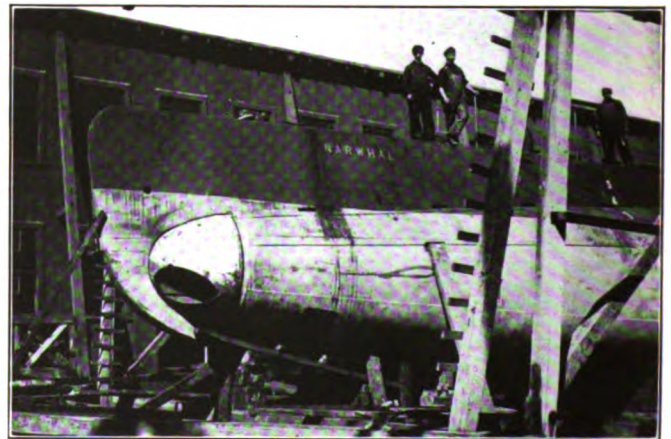
My father became interested in the subject of submarining when teaching school in Ireland in 1863. He read of the battle between the *Monitor* and the *Merrimac* at Hampton Roads, and he saw, of course, that the ironclad had come to stay. He set about to devise some weapon—something new—that could successfully combat an ironclad, and he finally decided that the submarine was the thing. He drew a plan for a boat at the time, but, of course, as is often the case with inventions, everybody thought it was nonsensical, and he had to abandon it. It was not until he came to Paterson, N. J., in 1871, that he succeeded in obtaining capital to build a small boat which he tried out on the Passaic River. It was designed to carry only one man. This boat was not armed nor fitted with a tube, but she had one great defect, as he found later. He had placed his diving rudders amidship instead of aft, as they should have been. His motor, which was supposed to be a petroleum engine, would "freeze" as soon as it got hot. He finally decided that it would be cheaper to build a new boat than to rectify the mistakes in the old one, so they took out the engine and fittings and sank the boat in the Passaic River, opposite West Side Park, Paterson, N. J.

This boat, the *Fenian Ram*, was built at the foot of West Thirteenth Street, New York, in 1881. The money was appropriated by the Fenian Brotherhood. The idea was not, as some people supposed, to build a boat to destroy the English Navy. At that time certain claims between the United States and England had not been definitely settled, and there was some talk of war. This boat was to cruise in the Atlantic lane between Canada and England to destroy what traffic she could. The boat was 33 feet long and carried a crew of three men—the pilot, engineer, and the gunner. She was propelled by a Brayden petroleum engine of 30 horsepower—the first successful one ever built. Beneath the floor were the ballast tanks and valves. There were no air flasks on this boat; instead, two large compartments, one forward, the other aft, were used. From both the compartments air lines ran to the torpedo tube forward and supplied air to the interior of the boat and to the engine, and to expel water from the ballast tanks. The diving rudders were placed aft.

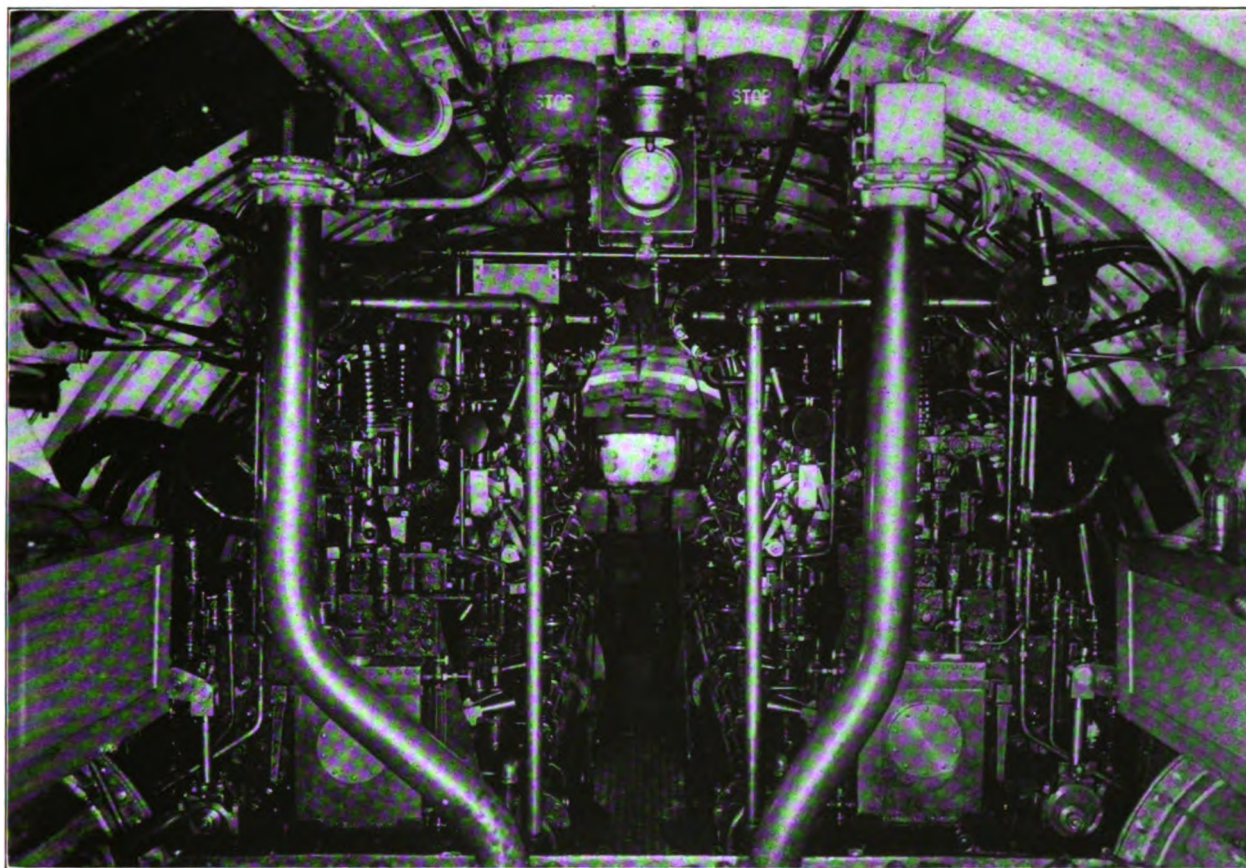
This boat was first tried in Morris & Cummings's breakwater in Jersey City. The first diving tests were very successful, and proved that the boat could do everything claimed for it. A short time after her first dive a reporter from the *New York Sun* visited my father and requested that he be allowed to inspect the interior of the



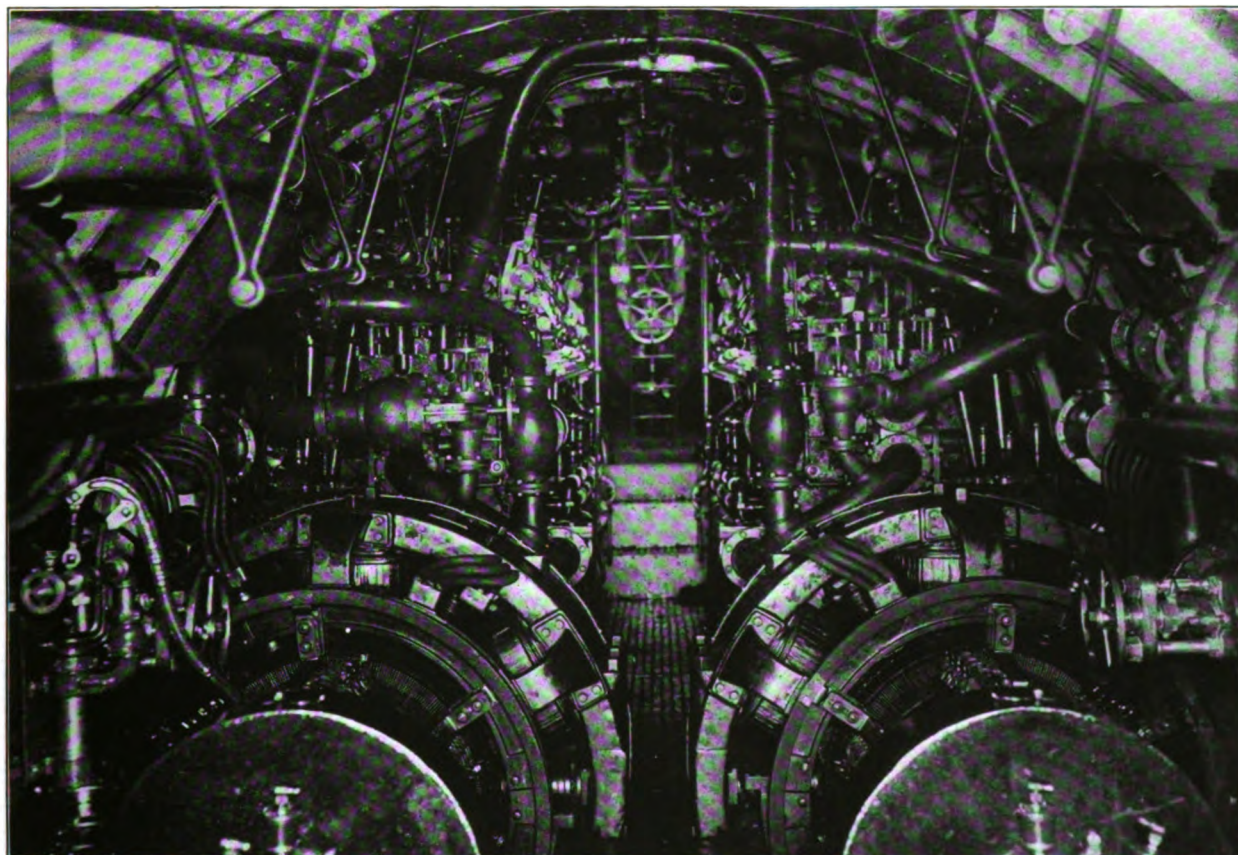
LAUNCHING A SUBMARINE



BOW OF A SUBMARINE WITH BOW CAP IN POSITION FOR TORPEDO FIRING



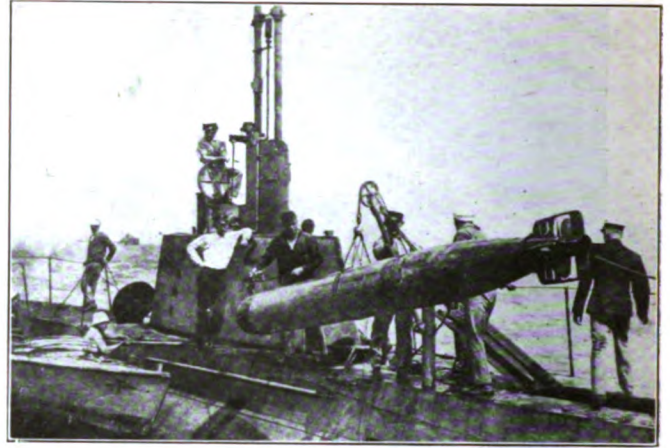
FROM AMIDSHIPS LOOKING AFT



FROM AFTER END LOOKING FORWARD



STERN OF A SUBMARINE



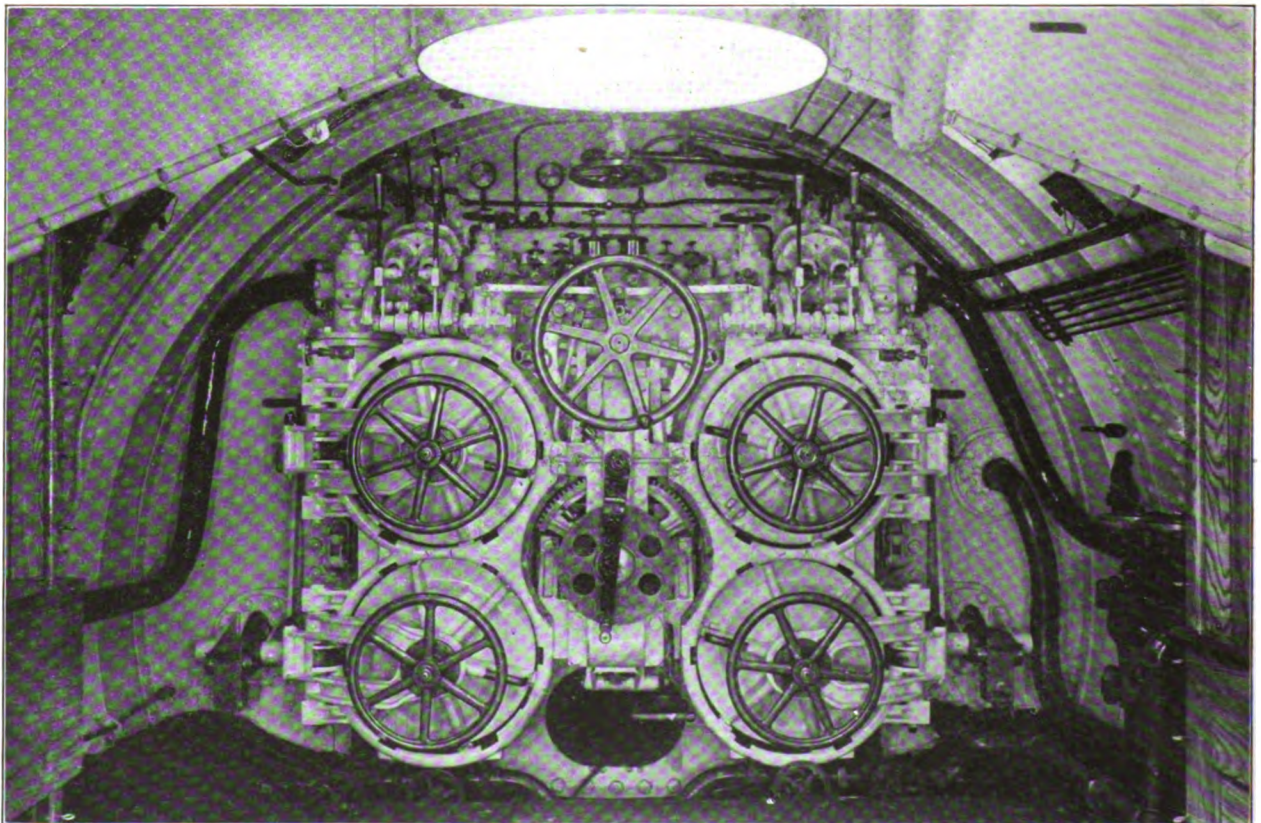
TAKING A TORPEDO ON BOARD

boat, but permission was not granted; so the reporter returned to New York and wrote a very elaborate article on the "Fenian ram," and that boat was ever after known by that name. The boat had no periscope, so it was necessary to come to the surface and then dive and run on dead reckoning. This was only the work of a moment, however, as the boat was very easily handled.

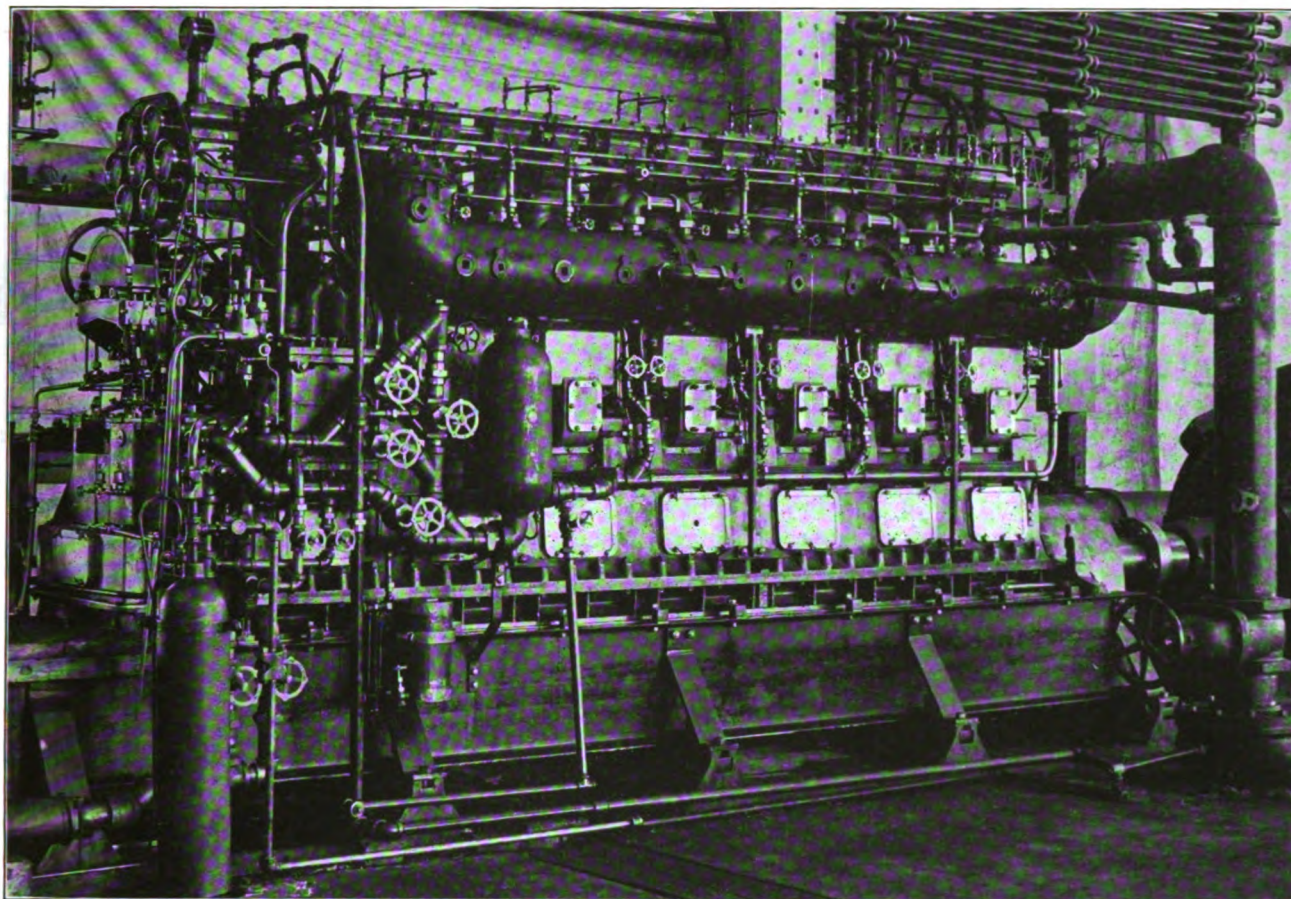
There is a rather funny incident I should like to tell in connection with this bow tube, the first time it was tried out. The test was made in Morris & Cummings's docks in Jersey City. Captain Ericsson, who designed the *Monitor*, was at that time building his destroyer, and he offered my father the use of two or three projectiles to make the test. My father accepted his kind offer, and

they submerged the boat three feet to fire the first shot. The projectile traveled 30 feet from the nose of the boat; rose up in the air about 40 feet; came down; buried itself in the mud, and was never found again. The second projectile traveled about the same distance; cleared the water; went over the breakwater bounding the basin; and struck some piling on the end of a pier, behind which a man was sitting, fishing. Fortunately, the man was on the right side of the pile. Later, when they fired a different type of projectile from that tube, it proved very successful,—and they had very few misses.

In 1895 the United States Navy Department advertised for plans for submarines. Three hundred thousand dollars had been appropriated to construct a submarine



INNER ENDS OF THE FOUR TORPEDO TUBES



450-HP. TWO-CYCLE DIESEL ENGINE

boat built in accordance with the best designs submitted in competition. My father submitted plans which were finally accepted. This boat was built from the money appropriated by the Government at the time, and was known as the first *Plunger*. She was built by the Columbian Iron Works, Baltimore, Md., in 1894, and was propelled by steam engines.

After the *Plunger* was abandoned, the Holland Company went to Mr. Lewis Nixon, who was at that time the proprietor of the Crescent Shipyard, in Elizabethport, N. J. He said that he would build a hull under certain conditions. My father said, "All right, go ahead," and construction was started in the fall of 1897. Before the work progressed very far a wealthy woman of New York gave us \$25,000 to defray expenses.

This boat was launched shortly after the destruction of

the battleship *Maine*, and it was pretty closely watched during that period. Her first trial was made on St. Patrick's Day, 1898. When they first tried to submerge it was found that the boat had too much reserve buoyancy, so they took pig iron on board for ballast. From that time on the eyes of the world were concentrated on her as really the first successful submarine boat.

The boat was propelled by a 50-horsepower gasoline Otto engine. When the boat was nearly completed they despaired of getting a suitable engine. My father happened to go to an electrical show in Madison Square Garden, where he saw an exhibit of an electric lighting plant for a country home. The generator was driven by a 50-horsepower Otto gasoline engine. He said, as soon as he saw the engine, "That is what I want for my boat," and he purchased the engine, which was placed in the *Holland*.



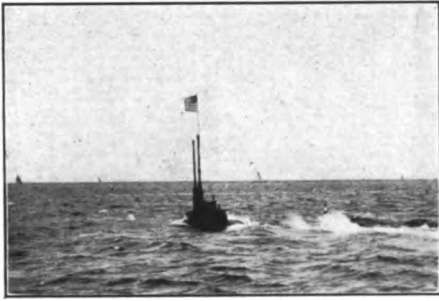
STRIPPED FOR DIVING OPERATIONS



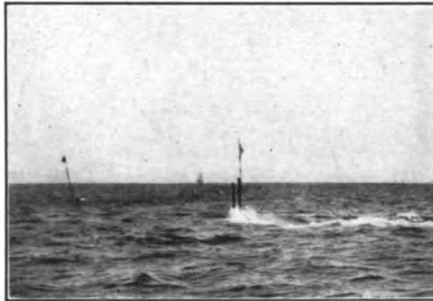
TRIMMED FOR DIVING



STARTING AHEAD WITH DIVING RUDDER AT ZERO



STARTING TO DIVE



DIVING



RUNNING SUBMERGED

In the other seven boats constructed for the United States Government Otto engines were installed.

During one of his dives in the lower New York Bay my father came near colliding with a lumber schooner. He came up just in time to see that he was pretty close, so he immediately dived fifteen or twenty feet to clear her. The following day a man came to see my father in his office in New York, and said, "You are Mr. Holland, are you not?" My father said, "Yes." "Well," said the visitor, "I am the captain of the lumber schooner"—naming her and stating where she was from, and so forth—and he said, "Yesterday you dived under my schooner as I was coming up the Narrows and your boat struck the bottom of my boat and seriously damaged her copper bottom, and I want to collect damages." My father replied, "Well, if such a thing had been the case your copper bottom would have ripped off the top of my conning tower, and I would not have been here to talk to you now."

After a dive the men lose no time in getting out of the boat for some fresh air, as there are all sorts of odors to be encountered in the interior of the boat; and, even

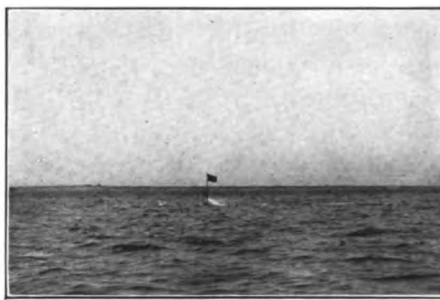
though they have a plentiful supply of air on hand, it is not as pure as the air outside.

After the *Holland* had been accepted by the United States Government, a contract was made with the Holland Company for seven more submarines to be built on the same lines as the *Holland*.

At the time my father was building his first boat in the Columbian Iron Works, Baltimore, Md., Mr. Simon Lake was constructing his first boat, about 25 feet to one side of my father's boat. Mr. Lake's boat was designed for salvaging purposes and dived on what we call the "even keel" principle. Instead of having one set of diving rudders, she had two. In order to dive it was necessary to be moving with considerable speed and gradually tip the diving rudders, or planes, as he called them.

This was the first boat Mr. Lake built, and he did considerable salvage work with it around Baltimore. The boat was not designed as a war submarine, and he did not take up that subject until later on.

EDITOR'S NOTE.—Mr. Holland's address was illustrated with numerous lantern slides of the many different types of the submarine boat.



STATIONARY SUBMERGED

LEATHER—TREATMENT AND MANUFACTURE *

By DR. LLOYD BALDERSTON

ASSISTANT CHEMIST TO THE ELK TANNING COMPANY; ASSOCIATE EDITOR, JOURNAL OF THE AMERICAN LEATHER CHEMISTS' ASSOCIATION; EDITOR OF LEATHER AND GLUE SECTION OF CHEMICAL ABSTRACTS

I AM going to begin by putting tanning in the same class as medicine. Doctors have been talking rather confidently about the science of medicine ever since I can remember, and yet I feel that there are many things in the practice of medicine that are not a part of the domain of science; and certainly the same is true of the tanning business. We are trying to get on to a scientific basis and are gradually achieving something in that line, and so are the physicians. So we are in the same class.

What is the reason why science has not got a grip on the tanning proposition? In the first place, we do not know what hide is chemically—that is, its constitution is unknown. What do we do to a hide to tan it? Treat it with tannin. What is tannin? Nobody can answer that question. What is the product? Leather. What is leather? Nobody knows. Those three statements are certainly true. Then what is the use of trying to talk about the scientific side of leather making? Well, evidently, none, and so I shall not address you as a scientist, but as a technologist, because we do know something about what to do to produce leather, and, even if we cannot tell you what the substances are which we use, we know the properties of the product which we make.

The place to begin, then, is the substance which is the principal raw material for the manufacture of leather, and that is skin. The skin of vertebrate animals, taken as a whole, is pretty much alike as to its constituents and possibilities of leather making. I do not mean to say that the product will be the same kind of leather, but that you can make leather out of the skin of a vertebrate animal—some good, some bad, and some indifferent.

What is skin? From the chemical point of view I cannot tell you much about what skin is; that is, from the point of view of its constitution. Of course, it is protein—pretty much all of it—hair, fiber, and everything else. We say, for instance, that the epidermis, the outside layer, and the hair are keratins. What does that mean? Some of you, no doubt, know better than I do. But, at any rate, those who have made a study of these nitrogen-containing substances classify them largely with respect to their hydrolysis products, and we class these together as keratins because they yield the same products of hydrolysis. I shall not discuss these further, as they are removed and the rest of the hide tanned.

Next under the epidermis comes the hyaline layer,

which makes a kind of leather which is extremely close grained relatively to the rest of the skin. It is made up largely of collagen (that is, of hide fiber, of which the rest of the skin is also made up), and this collagen is really different from the epidermis in several respects.

It is not attacked by tryptases which do attack the epidermis and the hair, and it is not soluble in dilute alkalis. It is possible to separate the epidermis and the hair from the rest of the hide by liming, or treatment with alkalis of various kinds, not in the shape of caustics, but sulphides, which undergo decomposition and yield a large proportion of caustic when placed on the hide.

The whole of the part of the skin which we tan goes under the name of corium, and this is made up largely of fibers. This fibrous portion consists largely of collagen, which in heavy hides constitutes perhaps 90 per cent of the true skin.

The remainder of it the tanner calls the interfibrillar material. This consists chiefly of mucoids—not one, but several probably. Elastin is one of the things that is also present. All of this material may be removed by digestive processes, the essential feature of which is the operation of enzymes which digest out the interfibrillar material and leave a more flexible structure when made into leather.

The material of the hide fiber is the same, so far as we know, with connective tissue throughout the body. It is therefore possible to tan a good many other parts of the body beside the skin, but the amount of material obtainable from making them into leather would not be much.

The difference between collagen and gelatin is, of course, a difference in molecular structure, which nobody understands at all fully. It has been suggested that the collagen molecule is a ring, a closed structure of some sort, and that certain digestive enzymes attack this so as to break open the ring and loosen some amino and carboxyl groups so as to produce a substance having more chemical activity.

The character of hide as a fibrous substance is well illustrated in the leathers which are made into gloves, for instance, because you can see the fibrous quality of that leather when torn or ground. Hide powder shows the fibrous structure very plainly indeed.

Here are two dry pieces of hide such as are ground up for hide powder. It is said that stretched skins are used for windows by some savages; you can believe it on looking at that. We do not prepare hide in that shape to make leather of it at all, but if we prepare hides for tanning and then instead of tanning them let them dry, that

* Lecture given before the Philadelphia Section of the American Chemical Society, at meeting of March 15, 1917, held at the Engineers' Club of Philadelphia.

is what we have—an extremely hard, horny, very elastic, resistant material. When Professor Michelson, of Chicago, was determining the velocity of light, some years ago, he had to make a revolving mirror spin at very high speed indeed, and, since its rate must be measured, it had to be driven by a pinion. He could not find any metal for this pinion that would stand the racket. Every sort of metal suggested “chewed up” when driven at such a high speed. Finally he made a pinion of rawhide, and it stood upon a pinion made of rawhide, only a few millimetres in size, spinning at hundreds of revolutions a second! It seems incredible.

The classification of hides is a subject about which much might be said. I shall mention a few of the hides and skins that are used in this country. The distinction between steer, bull, and cow hides is very real, although you might not think so. The bull hide is thick on the belly and the cow hide thin. Horse hides are tanned extensively. The carabao or water buffalo is also used to some extent, and we import from India many hides of the Indian buffalo, which are made into sole leather. Those are all the sorts of skins we are apt to call *hides*. When we have added the skins of calves, pigs, goats, and sheep we have pretty nearly covered all the standard types of raw material for leather. One of the kinds which is talked about in the market is cabretta. I have seen bales of them which I imagined came from the South American llama, but I have not found any one who could tell what animal wore them. At any rate, they are very extensively used in the manufacture of “kid” leather.

Our own native hides are usually brought to the tanner in a wet-salted condition. It would seem feasible to tan hides directly off the steer, but it cannot be done in practice, and I do not suppose such hides would make as satisfactory leather as if they had been through the process of salting. Hides are sold by weight, and when salted in the proper way the hide is left in a standard condition; that is if you give the hide all the salt it will take, it will take about so much and stop, so that when sold by the pound it has a definite value. But if the man who salts it puts in about 10 per cent. of aluminum sulphate, then it is something else than wet-salted hide. The aluminum sulphate partially tans the hide beside attracting water, so that it is very materially reduced in value per pound. A considerable proportion of the hides and skins sold in this country has aluminum sulphate mixed with the salt.

The other method of preservation besides wet-salting which is of most interest to us is plain drying; that is, the skin is hung up in the air and sunshine until it dries. If the climate is warm enough, skins can be dried in this manner pretty readily, and this process is used in India, China, West Africa, and certain parts of South and Central America. A large percentage of imported hides are thus “flint dried.”

Those are the two important kinds of *hides* we receive. The *skins* which we get, however, include one other method of preparation, and that is pickling. We get large quantities of sheepskins from New Zealand and

Australia, and they come to us, so far as I know, universally in pickle; that is, they are treated with a salt solution containing a certain amount of sulphuric acid which prevents them from decaying and leaves them in good condition for tannage.

What does tanning mean? I do not know, but I can tell you a few things that it involves. The hide fiber is very closely cemented together in dry hide, two samples of which are now being passed about the room, by the interfibrillar material and by the stickiness of the fibers themselves. If by any means these fibers can be prevented from sticking together, they will be flexible, and that flexibility is a usual characteristic of leather. Because of the fact that this separation of the hide fibers is an important thing, various modes of tannage have been suggested which do nothing else. For instance, the other day a gentleman brought me a sample of hide which was opaque, and when I bent it I found it somewhat flexible. He said “What is the matter with it?” Upon careful examination I said it had been frozen. That hide was hung up to dry on one of those days when the temperature was below zero and the remaining water in it had frozen and then dried out in the form of ice. That was leather instead of hide, because it was flexible. I cut the piece in half and soaked and dried one half. When the soaked half was dried again it was ordinary horny hide.

Leather may be made out of hide by soaking it in alcohol and then drying out the alcohol. That makes a kind of leather which has been dehydrated without giving the fibers a chance to adhere. A man named Knapp made that discovery more than fifty years ago, and it has been a cause of speculation ever since.

Hide is stronger, tougher, and harder than leather. Therefore, what is the use of spoiling it by making it into leather? You know that in the semi-arid country of the Southwest they can use rawhide for purposes which we would not find possible in our climate. Its flexibility is not conspicuous, but its strength is all there. The raw-hide lariat or lasso is a tremendously strong thing.

So far I have spoken of the methods used to make leather flexible. One other thing which is really necessary is to make it non-putrescible. You know that any kind of animal material is liable to the attack of organisms which rot it, and that is what happens to rawhide. Leather rots in a certain sense, but it does not putrefy, as hide will which is wet, because the putrefactive organisms cannot live in leather once it has been really tanned.

These two points are commonly mentioned as the characteristics of leather. But what is the standard process for converting hide into leather? The standard process is still a treatment with some sort of soluble material of vegetable origin which will produce this effect of separating the fibers and keeping them separated and rendering the substance non-putrescible. Of course, you know that means treating them with some kind of tanning infusion, which means almost anything extracted from vegetable material by hot water for this purpose. Nearly all vegetable materials contain tannin. Certainly an enormous

number of them do, but not very many of the ones that grow in our part of the world have tannin enough to make them valuable for tanning purposes. Broadly, I should say that tannin is any material present in vegetable tissues extractible by water which will convert hide into leather. You see, I am going around in a circle. It is a good deal like the dictionary definitions of a volt, an ampère, and ohm. Here is the definition which the Russian chemist Povarnin gives for tannin: "Tannin is a substance which will precipitate gelatin in the presence of salt in an acid solution." And that is the test which we usually apply to see if a substance contains tannin—get the liquid clear and then drop in gelatin-salt solution, and if there is a precipitate formed we say it contains some tannin.

Of course, you all know that tannins give blacks with ferric salts: blue-black for one class of tannins and green-black for others.

Tannin is difficult to purify. One reason is, because nobody knows when it is pure. But still it is possible, by several processes, to get a substance which is practically all precipitated by gelatin-salt, and when we find a substance like that we say that it is tannin, because it is all absorbed by hide.

One fact that you all know is that the best sort of tannin purified in this way is obtained from "nutgalls"—an abnormal growth on oak trees which was formerly used in the manufacture of ink, and is still, I believe kept in the pharmacopœia. Purified tannin from gall-nuts is called gallotannic acid; why they call it an acid is something of a problem. It shows acid properties, either by means of the hydrogen electrode or by titration with almost any of the ordinary indicators. It is acid, although very faintly so.

The purification processes are many. I will just allude to one of them. If tannin is precipitated out of a solution with lead acetate and the precipitate decomposed with hydrogen sulphide, the tannin is left in the water solution. A very pure tannin may be thus made out of any one of our tanning materials. Chestnut wood gives a very nice solution, if carefully treated in that way, in the absence of light. Light darkens all the tannins in some way; I do not know how.

A list of vegetable tanning materials would be enormously long. I shall mention a few of them because they are relatively more important than the rest. A generation ago the principal leathers were "oak" leather, "hemlock" leather, and "union" leather. Hemlock leather was tanned by hemlock bark. Some of you, no doubt, are very familiar with hemlock bark. Here is a piece. Its percentage of tannin is 10 to 12. It makes a red leather. The other sort of material very largely used, not only in this country but all over the world, is oak bark. Only one of our eastern oaks, the chestnut oak, with a tannin content of about 10 per cent, is valuable for tanning. This is a piece of chestnut oak bark. You all know, no doubt, that we have a large number of oaks in this country. For instance, black oak and various other oaks are sometimes brought

in wagons to tanneries and efforts made to sell them as chestnut oak. In California they tan an excellent leather with the bark of the California oak. This is a heavy bark, rich in tannin, averaging nearly 17 per cent. The difference between these two kinds of leather, oak and hemlock, which I hold in my hands, is partly in color and partly in texture, but either of them makes a good sole leather. If belt leather is desired, then oak is the only kind, because it is very much more flexible and less liable to crack on bending than that made from hemlock. A generation ago leather tanned partly with hemlock and partly with oak was known as "union" leather. But now union leather means a leather made out of any kind of tannin we can get. That includes a great many things which are neither oak nor hemlock.

A very important material is chestnut wood. We learned about chestnut wood as a tanning material from the French. We do not use this wood at the tanneries as we do the barks, because it gives too weak a liquor. The liquor is concentrated into extracts before being employed. I should say now that in the leather industry of this country chestnut tannin is used to the extent of 25 to 30 per cent in the making of heavy leathers, and it makes excellent leather. Its color is sometimes objected to, and perhaps justly, but the quality of the leather it produces is good.

The only other tanning material that grows in this country which is of commercial importance, so far as I know, is *canaigre* root, and this is a sample of it. These are pieces of the root of a kind of dock which grows in the West and makes an excellent leather. The problem of how to grow the plant is, as yet, very imperfectly solved, so that it is not extensively used.

I ought to include, however, among our native tanning materials the bark of the white spruce. In fact, either of our spruces—black or white spruce bark—makes very good leather indeed. We had a sample of some hundreds of pounds sent to the laboratory a few years ago, and ran a long series of extraction experiments. We tanned several pieces of hide with the extract made from it. Here is one of the pieces, marked "Tanned with liquor made from spruce bark." Please do not bend that double; it might crack. It has the characteristics of hemlock sole leather, although not quite so red. The reason I mention it is that much of the 1,400,000 tons of spruce bark that was being wasted yearly a few years ago is now being used in the manufacture of extract. That is a real service—to take a material habitually thrown away and make it into a valuable product. We have had a number of samples since that time from the pulp mills of the Northwest, and it is likely that other extract factories will be erected in the course of the next few years.

Of course, the hunt for tanning materials has been extremely keen since the war, and the cost of importing materials has been tremendously increased by the very great rise in ocean freights. To go outside of our own country—I will go over this list very rapidly—oak is the tanning material in England, Germany, and France. At

one time it was illegal to tan leather in England with anything else. It is regarded as the best material for the manufacture of most kinds of heavy leather. *Quercus robur* is the European oak whose bark is so largely used for tanning. There is another species in Slavonia whose name I do not recall. It is very similar in character, as to the kind of leather it makes, to our own oak.

Another of our native materials which is of very little importance except in certain kinds of light leather is sumach. Sumach is grown in Sicily, and the leaves are ground and sacked and sold in Europe and America for the tanning of light leathers, such as the sweat-bands of hats. It makes a very tough and very flexible leather. Sumach leaves contain about 20 to 30 per cent of tannin. I have pretty nearly canvassed the North American and European sources of tannin. One other worthy of mention is oak wood. Our oak wood has very little tannin in it—less than chestnut. One European oak which grows in Slavonia contains about 10 per cent of tannin and is used for the manufacture of oak-wood extract.

The rich tanning materials are nearly all tropical. One may make a general statement about tannins by saying that tannin is found in the bark, leaves, or fruit of trees that grow in tropical or semi-tropical countries, and then naming a few exceptions. Most tropical trees have tannin in their bark and in their wood. Many of them are objectionable as to color. In most cases the percentages are too low to make it worth while to ship them 4000 or 5000 miles to market. But, nevertheless, they contain tannin. So a list of the South American plants containing tannin would be a long list. I shall mention only three things from South America. The first is quebracho wood. I do not know how it ought to be pronounced. It is a Portuguese word meaning "axe-breaker." If any of you have ever tried to work some of it with edge tools you will think the name is justified. Here is a piece. I spent about fifteen minutes trying to get it smooth. It looks like mahogany. It darkens with age. It is extremely hard and very heavy and not strong. I made a screw-driver handle out of that wood and it twisted right off like a piece of licorice. I have about two dozen pieces of various sizes. If any of you care to carry home samples to experiment with, you are very welcome to take them. It looks like mahogany, but it is very much heavier. This wood has not been on the market very long. The story is told of a man traveling through Argentine Republic going past a saw-mill, seeing the peculiar sawdust and finding it was very astringent. That is one of the properties of tannin, in which respect it is somewhat like the persimmon, and this man said, "That must have tannin in," and that adventure, according to the story, is the beginning of the quebracho wood industry, which now uses about a million tons of wood a year. Tannin from quebracho wood was used for the making of leather both in America and in all the European countries before the war. Much extract is made from quebracho in South America and exported, and also much wood is exported. The wood contains about 25 per cent of tannin.

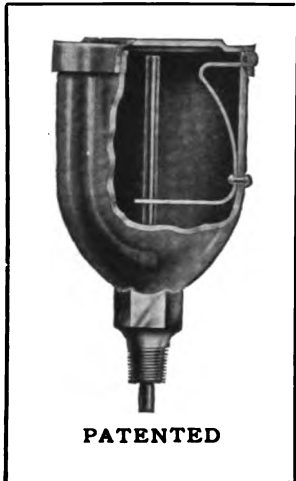
Of the South American materials, another one we import in quantity is the mangrove, which means any sort of tree that grows along the salt-water edge and out into the water. Of course, you know that mangrove coasts are found in South America and also in Florida. The bark of these mangroves contains about 25 per cent of tannin, which is very red, but of fairly good quality, and we import quite a good deal. The mangrove of Africa has a higher percentage of tannin and its color is also red.

There is one other material of South America used a good deal down there. It is the bark from a kind of locust tree, whose botanical name I do not know; they call it "angico." It is not exported. How many other tannin bearers there may be in South America no one knows yet, but one other of importance we do get, and that is this curious-looking material which I will pass around, which is called divi-divi. It is simply a bean, very much like a honey locust bean, excepting that it is much smaller and very much curled. I think about 70 per cent of them are worm-eaten. The seeds are of no value, of course, for tannin. Large quantities of this material are imported, and it is extensively used in all kinds of leather manufacture, because it contains tannin of very good quality. These beans contain something like 50 per cent of tannin; that is to say, about 50 per cent of the total weight is leather making material. This is only one of the leguminous fruits that are valuable for their tannin content. We are not able to identify some of them. A year or two ago we had a sample marked "guara," which is undoubtedly a fruit of the same description as divi-divi. I do not know what kind of tree it comes from. You can see the color of the leather made with it across the room. I think this is the nicest piece of leather I ever made in the laboratory for "feel" and general quality. It was made of a sheep "skiver." I am going to pass around these two dozen pen-wipers, and anybody who wants this sort of pen-wiper is welcome to take it home. You will notice that the top piece has a very satisfactory "feel." Neither of these had a thing done to them except to tan them. The lower piece is tanned in chromium sulphate solution. It has not been through any kind of a machine or oiled. The upper piece was tanned first with chrome and afterwards with guara.

Among those which are extremely important is this one, valonia cups—really nothing in the world but the bottom of an acorn from a tree whose botanical name is *Quercus agrifolia*. This comes from Turkey and is worth more a ton for making heavy leather than anything else sold. There has not been very much valonia sold in the United States in the last three years. Why cannot we gather divi-divi in Mexico, where there is plenty of it, and why cannot we gather acorn cups here? It is a labor question.

Of the other material which comes to us from Asia I was not even able to get a sample to bring here, because none of our tanneries has it in stock at present. It is called myrobalans. It is a very valuable tanning material indeed, and nothing more or less than a fruit,

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very much like a butternut. Just imagine a butternut, picked green and then allowed to dry, and you have a pretty good idea. It grows on a tree which is a native of India, *Terminalia chebula*. It is very extensively used in the manufacture of many kinds of leather. It is an extremely valuable material, second only to valonia among Asiatic tanning materials. Burmah, Siam, the Philippines, and the East Indies produce mangrove of quality comparable to the African. There are two other materials, gambir and catechu (or cutch), which have been known for a long while. Gambir is used by the East Indian people to chew, but we use it for glove leather. It was used in Europe for the manufacture of leather for two generations or more before anybody knew what it was made of. Finally, some explorer got far enough into Borneo to find out what the material was of which the natives made it.

Australia and South Africa grow several species of leguminous trees whose bark is valuable as a tanning material, and it is known in the market as "wattle bark."

Now, about the methods of manufacture. People have been making leather for a long while, and some of the primitive methods are still unexcelled for quality of product. For instance, the leather made of goatskins in Nigeria and marketed from the ports along the Mediterranean is used for bookbinding leather. You know when you bind a book with leather you expect the leather to stay there and keep on working for a long while. I have a book of poems at home which was bound in 1792, and the leather is just as good apparently now as the day it was put on. That is a long while. It was not tanned by a process involving the use of sulphuric acid, and that is true of all leathers that come from Nigeria, because in Africa they have no sulphuric acid. From many books that were bound thirty-five or forty years ago the binding has already fallen off, because those moroccos were made with processes involving the use of acids in the pickling or in the dye. The books bound with African leather, however, do not behave that way, because the primitive methods used there produce leather which lasts. In the Philippines they still use primitive methods. The bark which they use is most excellent tanning material, and the fact that the trade think it is excellent is proved by the prices paid for it. They are now paying something like \$40 a ton for the bark. They chop it up with machetes

- into chunks as big as your thumb, and then take half the tannin out and throw the rest away. And yet results achieved by primitive methods are sometimes surprising. In China, for instance, where they have primitive methods of making leather, a workman will take a carabao hide and split it into ten thicknesses with a knife. Splitting a piece of hide into ten thicknesses just by hand requires a degree of manual skill which is pretty difficult to realize.

Sometimes we mourn because we are losing our skill of hand. Chemists have less occasion for such regret than men in some other professions, but many men are deficient in manual skill because they make their living by using their brains. We may say there is no use of mourning the

loss of the skill of hand which artisans used to have, because machines do the work better. But do you believe that a man who is too old to play ball, and who never used his hands for anything more important, is just as well off as if he had kept on using them for some purpose? I do not. I think that the ideal citizen of the future will be a man that uses his hands as well as his brains to some extent. My father lived to be ninety. He kept his brain active by keeping his body active. Let us keep on using our hands, even if we do not have to split a skin into ten pieces.

In order to use the tannin of these various barks and what-not for manufacturing leather, we have to begin by leaching it out from the raw material. That part of the process is now on a fairly scientific basis, because we have found out with reasonable certainty the conditions of temperature and arrangement of leaches, etc., to get the best results. I need not go into that side of it; it is of more interest to extract makers than tanners, because there the results are much more easily measured up. In preparing hides for tannage, the first step is soaking, to get the salt out of salted hides or to soften dried ones. Dry hides have to be milled after soaking, to make them limp so that the tan liquors can penetrate.

The next step is to get the hair off, and that may be done, as I have already mentioned, in more than one way. For sole leather tanning, broadly speaking, there is but one employed—that is by soaking the heavy hide in a suspension of lime, allowing it to remain in the suspension, with frequent moving from three to ten days. The upper layer of skin is loosened and the hair is easily scraped off. The hair is not injured, but is sold for whatever purpose it is good for. If white, it can be used for "all-wool" clothing, and, so far as I can make out, it is as good as wool, in spite of the fact that it grew on the back of a cow instead of a sheep; but if not white it cannot be used for this purpose.

After the hair is removed the lime must be taken out. This may be done by the use of an acid or by bating or drenching or puering—any one of three processes which are practically identical in effect although not in name. The bating or puering or drenching bath neutralizes the lime and at the same time dissolves out the interfibrillar material, to make the leather more or less flexible or pliable. The extent of the treatment depends on the kind of leather to be made. For glove leather almost nothing is left but the fiber. Leather for shoes must be pretty flexible, though less so than glove leather. For harness the bating is comparatively little. The materials which used to be used in bating were pigeon dung and dog dung because, as we now know, they contain the enzymes or organisms which are necessary for the purpose. Nowadays these excrements are very largely replaced by artificial bates. One of these is made of a mixture of about 90 per cent ammonium chloride and about 10 per cent of pancreas, dried, ground up, and mixed with the ammonium chloride, and the organisms or enzymes contained in the pancreas furnish an extremely satisfactory substitute for the of-

fensive forms of bate formerly used. Another agent is the bran drench, which is an infusion of bran, made with warm water. After being mixed over night it is in a slightly acid condition, and is used to do the same work as the "puers" and "bates," though it is not so energetic. Then, after the hide or skin is delimed, it is ready to go into the liquors.

The process of tanning sole leather, of course, is much longer than for the lighter leathers. We may say, roughly, that the fresh hides are placed in a weak liquor, and as they get more and more tanned they are put into stronger liquors. It is a sort of continuous process, the hides moving in one direction and the liquors in the other. The time that the hides lie in each liquor increases as the liquors increase in strength.

What happens in the tanning liquor itself? Of course, we only know in an extremely general and imperfect way; but one thing is certain, I believe: The colloidal tannin—these tannin solutions are always colloidal—is absorbed by the hide fiber. When that happens the tannin undergoes a secondary change which causes it to be no longer recoverable as tannin. It remains attached to the hide fiber, whether it is combined with it in the chemical sense or not. At any rate, the tanning solution gradually penetrates the hide, and when it has got all the way through, then the hide is leather. If it is kept in the tanning liquor longer, the tannage is more complete, perhaps, and more tannin is absorbed by the hide. In making sole leather, that is what we want, because it produces a firmer as well as heavier leather.

The liquors must remain acid throughout, because otherwise the process does not go on nearly so rapidly. If the liquors are not distinctly acid, the hide is shriveled by the astringent quality of the tannin. These acids are produced in the tanning liquor by fermentation. In the process of tannage as the liquors go down in the yard fermentations are set up in them, forming both lactic and acetic acids. We find both volatile and non-volatile acids in liquors made from hemlock bark, chestnut, and other materials. Volatile and non-volatile are commonly present in about equal proportions in the stronger liquors. The non-volatile acid is usually chiefly lactic. We call lactic and acetic acids the natural plumping acids of the tanning process. If you have ever examined carefully the effect of acid on gelatin or hide, you know it tends to make the gelatin or hide swell. This plumping effect is regarded as essential if the leather is required to be thick and heavy.

Nowadays people are not satisfied to tie their capital up so long in making sole leather. The process used to take about two years. It has been shortened to about five months for the tannage of which I have been speaking. When you consider that hides are worth 20 cents a pound, wet-salted, and that a large tannery puts from 10,000 to 50,000 pounds into process daily, the amount of capital invested in hides at any one time is evidently very large. If the tannage could be done in two weeks instead of five months, we should save a lot of interest on money invested. On the continent of Europe the slow process

which we may call vat tannage had practically disappeared before the war.

In the drum tannage method the hides are placed in a revolving drum, with a comparatively small amount of liquor, which is rapidly strengthened. The process, instead of taking five months, takes only seven days, or even less. The leather so made is very nice looking. This piece was made in Ridgway. In one respect drum-tanned leather is always inferior. Water goes through it more easily than through the leather which has taken a long time in process. One reason is this: The tanning liquors in this process, involving months and months, deposit in the leather from the substance of the tanning liquor insoluble materials called "blooms," which help to prevent water penetration.

A piece of hemlock leather, tanned in the ordinary process, such as the one or two samples that I have here, will stand up for a week under a column of water a foot deep without the water getting through. The time of penetration for a drum-tanned piece is more likely to be half an hour than seven days. Such leather is suitable for dry-weather shoes. After tannage is complete, for the manufacture of sole leather nowadays we subject it to a filling process, putting it into a revolving drum, thrown in loose with a lot of warm, dense liquor, and drum it for a couple of hours. The dense liquor soaks into the warm leather and makes it much more firm and solid than it otherwise would be. Then, after immersion in warm liquor for two or three days to permit the tannin to get evenly distributed, it is taken out, bleached, oiled and dried, and in some cases, after being dried, again dipped in tanning liquor. The last process is rolling, which is much like ironing cloth. The leather is dampened and then rolled with heavy pressure.

British tanners criticise Americans because they put Epsom salts in sole leather, but they put in more tanning material instead of salts. It has the same effect. It makes the material heavier, more solid, and perhaps does not improve its wearing quality at all. Nobody knows whether it makes it any better. I suspect that it does not. The claim is freely made that the presence of sugar in soles to the extent of 4 per cent. is simply inviting pneumonia, and that it is largely responsible for the high death-rate from pneumonia and tuberculosis and so on. Such a claim is absurd. Leather containing small amounts of sugar and salts, if it was slowly tanned, is far superior in resistance to water-penetration to the rapidly tanned leather which has no sugar nor salts. There are objections to putting such materials in leather, but danger from pneumonia is not one of them.

I believe a real remedy would be to have a definition from some authoritative source as to what leather is and an agreement that leather should be sold by analysis. It is rather curious that when you want to buy almost any material except leather you say, "Is this up to standard?" Well, how am I going to find out? Analyze it, and if it is not up to standard, object. Did you ever hear of a shoe manufacturer analyzing a carload of sole leather to see

if it had anything in it which did not belong there? I never did. The manufacturer is not going to wear the shoes; he is going to sell them. Almost the only matter on which he insists is that leather shall be of a certain color, and color has very little to do with value.

So long as there is no agreement as to what leather is, we shall be "up in the air" in regard to this question of what is and what is not adulteration. I hope to see it put on a better basis in the course of the next few years. The real reason for the present state of affairs is that the parties who buy the leather are not the ones interested in its being the best possible leather.

Beside this standard tannage there is another form, in which alum is used. If you smear a paste of alum over a skin, roll it up or let it lie piled and later open it up and smear on some more alum paste, in the course of a few days the hide will be so changed that it will pass for white leather. White kid gloves used to be made of leather tanned in that way. They were simply hide again when they got wet, because the alumina salts soaked out with water.

A long article appeared in the *Journal of the American Leather Chemists' Association* translated from the French a month or two ago with a lot of speculation as to what happens between the alumina salts and the hide. Nobody knows. At any rate, a tannage results which will stand for some time if it is not washed too hard.

Chrome tannage is something real, because the basic salts of chromium produce a tannage which is exceedingly durable. Here are a couple of strips which are good examples. They are alike, except that one is heavier than the other. This leather is made from pickled skin. The tanning liquor is a basic sulphate or chloride of chromium. The hide absorbs the basic chromium salt, which stays fast to the fiber and not only resists washing with water (after tannage the next thing we do is to wash out anything that will wash out), but chrome leather will stand boiling. That is our test to see whether it is thoroughly tanned. If a piece is just the same shape and size after boiling for 15 minutes, we know it is tanned. I am exhibiting these two other pieces to illustrate the difference between the back and the belly of the hide. One of these is about 3-16-inch thick, the other not much more than 1-16-inch. That is one of the difficulties about chrome sole tanning. I have seen shoes made up with three or four thicknesses cemented together to make soles. There is nothing else to do with the thin parts. Here are three pieces taken out of three parts of another hide. The belly piece is quite flimsy. This is chloride tannage seven years old and does not show any sign of deterioration yet. This is a piece off the back; it is firm. The third is a piece of cheek, the firmest one of all.

I suspected, when we began this process of making chrome soles, that the presence of sulphuric acid in the leather would eventually cause it to rot. The oldest piece of sulphate leather I have here is about four years old. This piece which I hold in my hand was pickled with formic acid instead of sulphuric acid and tanned with

chromium formate instead of sulphate. I am keeping that to see how it behaves. It is about five years old. Somebody has a patent on the formic process, but it has not been used commercially, I believe.

Chrome tannage certainly stands second in the processes of tannage now employed. I suppose the uppers on men's shoes in the United States made by chrome tannage would include something like 90 per cent. of the total. They are dyed black and all sorts of colors so that they do not show the green color natural to chrome leather. If you get your shoes wet nowadays and dry them again they are tolerably flexible. When I was a boy shoes which had been wet would be exceedingly stiff when dried if they were not oiled. It seems as if the fiber of chrome leather is not so affected by water as that of vegetable tannages. The fibers remain flexible and separate, and even when the water passes through the leather it seems to go between the fibers without affecting them.

One of the strange things to me is the fact that you can take the same piece of hide and tan it both ways—no either way, but both ways. Last summer I was trying some experiments in the sterilization of hides. These were some of the pieces. After the pieces were sterilized I tanned them with chromium sulphate. Then they were soaked for about four months in vegetable tanning liquor, which penetrated very slowly indeed. They were pieces of dry hide, and in order to make dry hide tan properly it must not only be soaked but pounded and pounded many times in a mill. The chrome tannage goes through all right without milling, but the vegetable very slowly. These pieces of leather are thin, but they are nevertheless completely tanned, both with chrome and vegetable tannin.

Professor Procter used to explain this by the assumption that the hide is amphoteric. It acts like a base, having amino groups which unite with the acid of the tannic acid, so as to form a compound in which the hide is the base and the tannin is the acid. Also the carboxyl groups of the hide react with the basic chromium salt so as to form a compound in which the chrome is the base and the acid is the hide. Either of the two tannages may be carried through first and followed by the other. Whether this chemical explanation is correct or not I will leave to those who are now more versed in chemical theory than I. At any rate, it is true that you can tan a piece of hide with vegetable tannage completely all the way through, and then with chromium all the way through, or *vice versa*. This piece of leather (indicating) can be boiled without injury and will wear like chrome leather and doesn't slip. Take a straight chrome sole like those two strips which are being passed around and walk on a wet pavement. You will find the sole as smooth as though it had been greased. The only reason I know of why this combination tannage is not commonly made and sold is that it costs twice as much to make, because it has to be tanned both ways.

Almost any other kind of a metallic substance will tan leather. Professor Procter's general statement is that

you can tan hide with almost anything! Copper solutions are capable of producing tannage. Here is a piece of leather which, so far as I know, is unique. It is tanned with iron. I simply put a piece of sheepskin in a solution of copperas and added soda solution a little at a time and kept it churning in a drum, every day adding a few cubic centimetres of soda solution. It is about four years old and is as tough a piece of sheep leather as I have ever seen. The only trouble is that I have never been able to duplicate it. I may possibly try again.

Cerium compounds and thorium compounds, and a great many others, are capable of producing tannage. Just ordinary, every-day sulphur will tan. The sulphur which is precipitated by acid in a thiosulphate solution tans hide that is put into the solution really quite efficiently—not very resistant to water, but still good tannage.

In addition to the several methods of tannage which I have mentioned, there is the two-bath chrome process, largely used in the manufacture of light leathers. It is entirely different from the process used for heavy hides. The leather, instead of being directly treated with the basic salt, is soaked first in bichromate of soda or potash, and then the reduction is done right in the skin by placing it in a thiosulphate bath which reduces the bichromate and precipitates basic chromium sulphate—if you choose to explain it that way—and we have the reduction to the basic salt in the hide. This is a process involving only a few hours. It is used in the tannage of sheepskins, goat-skins, and other thin skins.

The Chinese tan skins by hanging them up in smoke for several days, which makes a very resistant leather, but the process is extremely uneconomical. Yet that is the only way that the Chinese seem to know how to do it. This leather is used quite extensively among the Mongolian tribes. Formaldehyde is capable of making leather. Quinones or hydro-quinones make a very good leather, and a very small proportion is necessary to produce tannage.

One of the very interesting new kinds of tannage uses an artificial tannin-like material invented by Dr. Edmund Stiasny. The material is called neradol. Crude cresol is treated with sulphuric acid, then formaldehyde is added and the solution nearly neutralized with soda, and the result is a liquid looking like thin molasses. This "extract" can be diluted into a liquor of comparatively low density and used to tan skins in a great variety of ways. It is one of the most universally useful tanning

materials there is. It makes a white leather which is washable and very tough. You have all met with white kid gloves that can be washed. They are probably tanned with neradol. I shall mention only one other sort of tannage.

When you want a piece of leather to rub down your washed windows you get a piece of chamois, which means the under-grain split of a sheepskin which has been oil tanned. They simply treat the skins with almost any kind of a marine animal oil—keep them agitated for a time, and then pile them in boxes. They get warm presently, and when the tannage is complete, which only experience can determine, the oil is washed out of the skin by any one of several processes. Sometimes they press out the first portion and then wash out the rest with soap and then dry the tanned skins. That is the *chamoisage* of the French. It is practised largely in this country on the under-grain splits of sheepskins.

Enormous quantities are used, because all the trades in which polishing is done employ chamois leather in large quantities. The so-called "rawhide laces" used for belts are made by this process. The oil used for the purpose has to be a semi-oxidizing or oxidizing oil. (Samples exhibited). This is rough belting leather. The little pits are places where bits of oak bark have rested against the skin when the hides were piled on top of each other. Only the best qualities of hides can be used in the manufacture of belting. The contrast between the leather made from the back and the belly is nicely illustrated by these two pieces.

Of the familiar substances employed for tanning leather, no two are more widely known than oak and hemlock; and this is the difference between oak and hemlock in color. You can see fairly well across the room. This is called scoured oak because the grain has been washed and polished. The other is an untreated piece of hemlock leather. Here are two samples which give you an idea of what chestnut leather looks like. Chestnut leather is rather dull in color, but by combining chestnut with other things—oak, for instance, leather of very good appearance may be made. So far as toughness is concerned, chestnut leather is very good by itself.

Here are some examples of pieces of sheep "skiver" tanned with chestnut, to give some idea of its color. The quality is poor, as you can see, but that is largely because this was a sulphuric acid pickled sheepskin and was kept a long time before it was tanned.

(The speaker invited questions, and a lengthy discussion followed).



AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS .: PHILADELPHIA SECTION

H. P. LIVERSIDGE, Chairman

W. F. JAMES, Secretary, 1442 Widener Bldg.



THE JUNE MEETING

IT has been our custom in past years to close the technical program for the season with the May meeting and devote the final meeting, in June, to the election of officers for the coming year and to the annual dinner.

In considering the plans for the June, 1917, meeting your Board of Managers has concluded that, in view of the unusual national conditions existing at this time, it would be unwise, if not improper, to prepare the usual program with its purely social and entertainment features. It is therefore planned to hold the June meeting at the Engineers' Club, beginning with the usual informal dinner at 6 P.M., and, following the election of officers at 8 P.M., it is hoped to have one or more speakers to touch upon the present conditions as they affect the electrical engineer and his obligation to the nation.

A more complete announcement will, of course, be mailed to all registered members several days prior to the meeting, which will be held on Monday, June 11, 1917.

SPECIAL NOTICE

A registration card has been sent to each member of the American Institute whose name has been furnished by the New York headquarters as residing within a fifty-mile radius of Philadelphia. A large percentage of these cards have been returned with the necessary information as to correct address, etc., but many have no doubt overlooked the matter, and it is requested that they be returned promptly, so that our mailing lists may be made complete and up to date.

If by chance you have not received a registration card, please advise the Secretary and you will be registered immediately.



AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS EASTERN PENNSYLVANIA CHAPTER

GEORGE W. BARR, President

GEORGE BOON, Secretary



THE regular monthly meeting of the Eastern Pennsylvania Chapter of the American Society of Heating and Ventilating Engineers was held Thursday evening, May 10, at the Engineers' Club. "Automatic Control as Applied to Heat Regulation" was the subject presented by Mr. S. E. Plewes. The models of improved present-day devices exhibited by Mr. Plewes illustrated very forcibly the great advances made in recent years. Mr. Plewes attributes the "positive reliability" of modern automatic control over manual control to the highly developed design and special materials now used in manufacturing regulating devices. Many interested members and guests examined the demonstrating apparatus.

Mr. John F. Hale, president of the Society, 1913-1914, has returned to Philadelphia as vice-president of the Braemer Air Conditioning Corporation. Mr. Hale is known to the members of the Society by the results of his activities for many years in the Chicago and New

York Chapters. The members of the Eastern Pennsylvania Chapter extend a sincere welcome and good wishes to Mr. Hale.

The movement recently started to encourage closer coöperation between Chapters deserves the hearty support of all members of the Society. The interchange of courtesies between Chapters makes for closer relations and is of mutual benefit.

The question of the advisability of a semi-annual meeting is again up for discussion; considering the many unusual conditions due to a state of war several organizations have decided to dispense with their semi-annual meetings and devote the funds so saved to the Red Cross or other worthy causes.

Members are requested to advise the Secretary of any matters of interest to the Chapter occurring during the summer vacation, and be prepared individually for a vigorous fall campaign, starting with the next regular meeting, October 11.



TECHNOLOGY CLUB OF PHILADELPHIA



H. A. TERRELL, President.

G. W. BARNWELL, Secretary,
33 Cooper St. Camden, N. J.

THE last meeting held at the Engineers' Club, on the evening of May 2, was in the form of a get-together smoker. Dinner was served in the private dining-room behind the library, and the privacy added much to the "get-together" spirit. After dinner we adjourned to the auditorium, where we were joined from time to time by later arrivals. A smoker was the order of the evening, and many matters of interest to the club were discussed informally. The war and its relation to Tech. men was the chief topic, and Mr. Terrell, Mr. Willard, and Colonel Lyle were heard from along this line. Mr. Terrell read the following letter from I. W. Litchfield, which goes to show that Technology and Tech. men are taking an active part in national affairs:

ALUMNI COMMITTEE ON MOBILIZATION OF TECHNOLOGY'S
RESOURCES APPOINTED BY THE ALUMNI ASSOCIATION
OF THE MASSACHUSETTS INSTITUTE
OF TECHNOLOGY

EXECUTIVE COMMITTEE

I. W. Litchfield, '85, Chairman, M. I. T., Cambridge, Mass.
J. P. Munroe, '82, Sec.-Treas., 79 Summer St., Boston, Mass.

Charles A. Stone, '88. Raymond B. Price, '94.
M. L. Emerson, '04.

CAMBRIDGE, MASS., April, 1917.

To the Members of the Committee:

At the meeting of the Technology Clubs, Associated, in Cleveland, last week, the following resolutions were passed and were followed by subscriptions of \$2750 made on the spot:

"WHEREAS, The Technology Clubs, Associated, have expressed, through their representatives at this convention at Cleveland, an earnest desire to coöperate with the Committee on the Mobilization of Technology Resources in the placing of those resources at the service of the National Government; and

"WHEREAS, It is evident that the present crisis demands, above all else, the counsel and activity of technically trained men; therefore, be it

"Resolved, That an Executive Committee of five be appointed by the President of the Technology Clubs, Associated, to coöperate with the Committee on the Mobilization of Technology Resources in organizing the Technology Associations of the country in a joint effort to ascertain those national problems in the solving of which these bodies can be of the greatest service and to secure prompt and effective action regarding them.

"Be it further resolved, That headquarters be at once opened in Washington, with a permanent representative and a sufficient staff to carry out the above plan, and that the Technology Clubs, Associated, as organizations, coöperate with the Committee on the Mobilization of Technology Resources in the work of financing."

I am receiving letters from men in all parts of the country, many of whom are connected with the government service, who feel that the first duty of citizens is to urge Congress to act speedily on the important subjects before it. It is suggested that local committees address their congressional delegates, urging speedy action on some of the great matters that it is necessary to have settled, and settled rightly, before our coöperation can be effective. They can also use their influence with other organizations, societies, etc., to do the same thing.

Yours truly,

I. W. LITCHFIELD.

IWL/L

Of the \$2750 subscribed, \$250 was contributed by Dr. Hollis Godfrey in the name of the Technology Club of Philadelphia.

CLEVELAND MEETING

At the meeting of the Technology Clubs, Associated, in Cleveland, on April 19, 20, 21, Doctor Godfrey was elected president of the Associated Clubs. In the name of the Philadelphia Club, he invited the Associated Clubs to meet here next spring, so it is surely our duty to see that the meetings will be successful and the occasion a memorable one.

ANNUAL FIELD DAY, JUNE 2

The following, a copy of the notice to be mailed each member of the club, will give an outline of what is expected of our annual field day:

MOBILIZATION ORDERS

SIR: You are hereby ordered to report on Saturday afternoon, June 2, at 2.15 o'clock, at the Woodbury Country Club, Woodbury, N. J. Permission is given to all married men to bring their wives and children. Permission is also given to all single men to bring their best girls or the best that they can get. The official transport train leaves Market Street Ferry (Pennsylvania Railroad) at 1.45 P.M. and leaves Camden (steam train) at 1.52 P.M., arriving at Woodbury at 2.15. Transportation will be furnished *free* to all who make a suitable deposit with the

ENGINEERS' CLUB OF PHILADELPHIA

Pennsylvania Railroad prior to the departure of the transport train. Recruiting officers will be in attendance at the Woodbury Station to direct all "rookies" and others to the Country Club. On arriving at the Country Club all wants will be attended to by the "Technology Red Cross," in charge of Mrs. E. P. Trask, Mrs. E. E. Pierce, Mrs. D. K. Bullens, Mrs. C. J. Walton, Mrs. Donald Frazier, Mrs. F. E. Waters, and Mrs. H. A. Terrell.

For greater facility in the training camp, all "rookies" will be divided into two classes, the Red and the Gray, and the training stunts arranged accordingly. Each "rookie" is requested to bring with him the following: Any baseball stuff, such as gloves, bats, etc., which he may possess; 1 old suit of clothes, 1 old pair of stockings, 1 old pair of shoes; also such other articles of wearing apparel as the law requires. There will be room in the barracks for changing uniforms, etc. All of the training events will be Reds vs. Grays, and will consist of

Baseball Game
Sack Race
Centipede Race
Shoe Race

Relay Race
Tug of War
Mystery Race

Mess, 6 to 7 P.M. Served by the losing side. In order that rations may be provided for all, you are requested to fill out the enclosed card and mail as promptly as possible to

Commissary Serg. E. P. Trask,
123 North Davis Street,
Woodbury, N. J.

LET THERE BE NO SLACKERS

7-8 P.M. Song Recital—M.I.T. Songs
Music for the evening will be rendered by the
TECHNOLOGY RENDERING SOCIETY

Dancing 8 P.M. ?
Official Photographer—Major H. L. Walker.
Official Score Helper—Judge C. F. Willard.
Judges—Col. D. A. Lyle, Col. Benjamin Adams.
Charges—\$1.00 for each member, 50 cents for each guest.

10 cents rebate for each techlet.

To really appreciate it, though, one has to be there. A cordial invitation is herewith extended to all members of the Engineers' Club to join us on that day.



AMERICAN SOCIETY OF MECHANICAL ENGINEERS .: PHILADELPHIA SECTION

EMMETT B. CARTER, Chairman.

W. R. JONES, Secretary, Eng. Dept., Univ. of Penn.



A MEETING of the Philadelphia Section was held at the Engineers' Club, 1317 Spruce Street, on Tuesday, April 24, at 8.15 P.M. Mr. D. Robert Yarnall, M.E., of the Yarnall-Waring Company, presented a paper on the "Recent Development in V-Notch Weir Measurement."

The paper was fully illustrated with lantern slides. The speaker traced the early history of the V-Notch Weir, showing the various steps in its evolution to the very modern and successful form. Particular emphasis was put on the fact that the V-Notch Weir, irrespective of the particular make of the instrument, is the most successful form of measurement for liquids. The results of the tests made in the laboratory of the University of Pennsylvania were given. In the test a Lea instrument was used.

The accuracy curve for various rates of flow was practically a straight line. The water used in the test was weighed by very accurate scales. The percentage of error during the entire test was about six-tenths of one. The guaranteed accuracy of most instruments of this type is about $1\frac{1}{2}$ per cent.

A discussion followed, in which Messrs. Ledoux, McBride, and Moody participated. We are pleased to announce that this paper will be featured in the July issue of the PROCEEDINGS.

At this meeting the Committee on Nominations submitted the names of candidates for the several offices during the coming year. This report was adopted and the candidates named therein elected. A report of the action taken has been sent in to the New York office for approval.

On Tuesday evening, May 22, there was held at Drexel Institute a joint meeting of the Society and the Engineers' Club.

Mr. Willard Behan spoke upon the subject "The Engineering of Men." Mr. Behan is a railroad engineer and has been a most successful executive, and has the enviable record of never having had any trouble with his employees. He spoke upon the ethics of employment and the relation between the employer and employee.

A very large attendance marked the meeting, representatives of all the Affiliated Societies being present.



ILLUMINATING ENGINEERING SOCIETY PHILADELPHIA SECTION

ROBERT B. ELY, Chairman

T. ELMER MOON, Secretary



ROAD ILLUMINATION BY MEANS OF AUTOMOBILE LAMPS

(Continued from May PROCEEDINGS)

If such a state of affairs did exist, it would be necessary to limit the power of headlamps to such a point that the glare produced would not be so great, but that all the users of the highway could get by each other, some way or other, and at the same time they would be able to have enough road illumination to proceed at a slow rate of speed. The question would then be simply one of road illumination *versus* glare.

If, however, we accept the solution of directing the light toward those portions of the roadway which it is necessary to see, and by keeping strong light intensities away from the pathway which would be followed by the eyes of the drivers of approaching vehicles, the problem then becomes much simpler. The problem then consists of determining just what light pattern is the best to project, and of furnishing suitable devices with engineering instructions for their use so that the ordinary driver of automobiles can utilize this light distribution on his car.

LIGHT PATTERNS PRODUCED BY PROJECTORS

The light pattern of a projector and its effect on a road were illustrated by rather novel means. Two negatives, superimposed so that their axes coincide, are printed together: one shows the light from the headlamp projected on a screen placed at a definite distance from the source and marked to show the angular spread of the beam, the other a view of the road. When printed, those portions of the road which would not receive light directly from the headlamp are black, while those which would be illuminated by the headlamp show the picture of the road. By this means it is possible to show how brightly the road will be illuminated, both nearby and at a distance, and between what limits an approaching driver would experience glare. Several types of headlamps were discussed and freely criticised.

Where a diffusing type of cover-glass is used in front of a parabolic reflector the glare is reduced, but only to an extent corresponding with the reduction in beam intensity. An approaching driver is still in the beam of the headlamp from the most distant point until he is even with the headlamp, and will, if the

intensity is sufficient to properly illuminate the road, experience a blinding glare. From the standpoint of the driver of the automobile equipped with such a diffusing device, the foreground is so brilliantly illuminated as to reduce the sensitiveness of the eye to the more distant parts of the road, and, unless bulbs of excessively high power are used, wagons and other large obstacles will suddenly loom up at short distances in front of the car with confusing suddenness.

WHAT IS GLARE?

Having taken up the problem of road illumination mainly from the standpoint of the driver, how are we to determine what constitutes glare? If we look directly into a glaring headlamp, objects near this headlamp cannot be distinguished. From photographic experiments made, one might say, roughly, that if the beam in the direction of the driver's eye does not exceed 1000 candle-power, and if a reasonable road illumination is produced by his own headlamps, the glare will not be of such high intensity as to be seriously disturbing. When, however, the maximum beam candle-power obtainable from a parabolic reflector (that is, a beam of 20,000 to 60,000 candle-power) is projected into one's eyes, it is impossible to see anything beyond the headlamps.

Where the Type B or macadam roads, on which glare is prone to be the greatest obstacle to safety and comfort in driving, are provided and maintained by the state, their use is legitimately subject to state control for the purpose of securing the greatest usefulness and safety for all travelers on the highway. The legislation now being enacted has some regard for the scientific requirements of illuminating engineering, thanks to the agitation of the automobile clubs, the engineering data supplied by the Illuminating Engineering Society, the Society of Automobile Engineers, and to a certain extent by the manufacturers of anti-glare devices.

Where, as at present, there is no stamp of official approval of a particular device, the car owner does not know whether his car complies with the law or not.

If a certain light distribution is passed upon as legal, without regard to the device or means employed, the responsibility of securing the required distribution rests with the car owners. In the present state of the general knowledge of the car user of the laws of optics, a vast amount of education will be necessary before

the law can be intelligently complied with. If, however, all car owners honestly attempted to eliminate the "blinding glare," specified in many ordinances, in directions in which this glare should not exist, few cars would present any difficulties in passing.

While there are serious drawbacks to giving official permits to special devices and allowing freedom

from police interference to users of such devices, would it not be entirely feasible to give permits stating that when certain devices are properly installed and the headlamps properly adjusted the ordinance can be complied with, thereby eliminating the many devices so crudely designed that by no adjustment whatever can they be considered as glare eliminators?

MACADAM ROADS

It is instructive sometimes to change the point of view in discussing a subject and before passing judgment on it, just as in a matter before the bench the judge has the benefit of statements both from the prosecution and the defence before giving a decision. The way in which a macadam road is built is known so generally that reference is now rarely made to it; but how it is destroyed is quite a novel way of discussing it. Mr. T. W. Arnall, in a paper presented at the recent annual meeting of the Institution of Municipal and County Engineers at Blackpool, has done the latter thing, so here we are presented on the one hand with the forces of attack, and on the other hand with the forces of resistance. Shall we condemn the road or shall we condemn the traffic? Let us see.

The intensity of pressure on the foundation of a road, communicated through the whole thickness of metal depends on two factors—(1) the width of the tyre, (2) the diameter of the wheel. For the same load on a wheel (let us call it one ton), assuming that the load is transmitted downwards to the base in the form of a pyramid with sides sloping at 45° we have the following data—First, width of tyre 3 inches, depth of metal 6 inches, load on surface 1 ton; then at bottom of metal, that is, on surface of foundation, we have the one ton of load spread over a width of $(3+6+6)$ 15 inches. Next, width of tyre 6 inches, and other data the same; then, on surface of foundation we have the one ton of load spread over a width of $(6+6+6)$ 18 inches. Thus by doubling the width of tyre we have gained an advantage in distribution of pressure over the foundation of 20 per cent. But as the areas of the bases of the pyramids are, respectively, 177 and 255 square inches, the gain in area over which the ton is distributed on the top of the foundation is 44 per cent. Let us next consider the effect of wheel diameters. As the load must force a wheel into the surface of a macadam road to some extent, let us suppose the road to dip one inch. In this case the load will bear on the road surface for a length of $9\frac{3}{4}$ inches (say 10 inches),

in the case of a 2 feet wheel and for a length of 1 foot 2 inches in the case of a 4 feet wheel. Thus, at bottom of metal, that is, on surface of foundation, we have the one ton of load spread over a length of $(10+6+6)$ 22 inches in the one case and of $(14+6+6)$ 26 inches in the other; and as the areas of the bases of the pyramids are, respectively, 380 and 531 square inches, the gain in area over which the ton is distributed on the top of the foundation is 40 per cent. by doubling the diameter of the wheel. This is assuming that the pressure along the whole line of contact is uniform which, of course, is not exactly the case. Now, conditions before the advent of commercial motor transport were—smaller wheel loads, comparatively wider wheel tyres and larger wheel diameters, each of which is a factor in keeping down loads on the foundation. Commercial motor vehicles being heavier by a long way with tyres narrower in proportion to load and with wheels of less diameter bear much more heavily on the road foundation and would bear more heavily even were the wheel load not greater. And there is beside the greater effect of impact due to their greater speed. So much then for the effect on a road foundation of wagon traffic and of heavy motor traffic.

Considering next the effect on the metal itself, the whole mischief in the case of a macadam road is the appreciable sinkage of the surface under pressure. Obviously, the surface cannot sink without a displacement of the material of the whole of the pyramid under it and such displacement cannot occur repeatedly without grinding and loosening the material of which the road is composed; nor can such grinding and loosening continue for any period of time without complete destruction of the road. And this destruction will be effected the more rapidly and completely the greater the wheel load and consequently the greater the amount of sinking in the road surface under pressure. The case for the macadam road therefore is this—that it was quite adapted to the traffic for which it was originally designed.—*Indian Engineering.*

INDUSTRIAL NOTES

THE decision of the Nazareth Cement Company to electrify their plant and mill in the early part of 1914 occurred about the time our Engineering Department, after exhaustive experiments extending over a number of years, had definitely found the solution of certain difficulties which had previously hindered the use of silent chain drives in cement mills.

Early in our investigation we determined that the controlling factors were proper lubrication and protection from prevailing grit, and in due time we developed and patented means which now enable cement manufacturers to take advantage of the superior qualities of silent chain drives, with every assurance of their successful operation.

Because of our knowledge of the conditions under which silent chains are required to operate in cement mills, and the fact that the compact, efficient silent chain drive is the simplest and most desirable means of transmitting power to cement mill machinery, we were entrusted with furnishing 32 Link-Belt silent chain drives for their mill, totaling 3500 horsepower, ranging from 35 to 150 horsepower each. These drives were installed and started in operation the early part of 1915, and are being operated constantly. Needless to say, the eyes of the entire cement industry were focused on this large installation. The unqualified success of these drives led to the adoption of silent chains by other mills throughout the country, and to-day Link-Belt silent chains are being recognized as ideal drives for cement mill machinery.

This equipment operates under the grueling conditions that cement manufacture involves—widely varying loads, with full load or overload coming on suddenly, as the material handled varies in volume. The vibrations naturally caused by the unbalanced action of the driven units in such plants are not transmitted to the motor, and the armature is protected against the shocks it would be called on to endure with a spur gear drive, because the silent chain is flexible, and offers enough elasticity to cushion or absorb these shocks.

After ten months' service, twenty-four hours per day, a careful examination of these silent chain drives showed that they were practically as good as when installed—there was no evidence of undue wear on the chains or on the wheels. This indication of durability is but another reason why Link-Belt silent chains are winning constantly-increasing recognition from engineers and mill superintendents throughout the country.

Another great advantage is in the compactness of the silent chain drives, as will be seen in the views which show a series of drives in a line. Belt and rope drives

would have required long centers and made it necessary to stagger the motors and interweave the drives. For instance, No. 1 mill would have been driven from a point between the third and fourth; No. 2 from between the fourth and fifth; and No. 3 from the outside of No. 1, etc.

To walk through the Nazareth Cement Company's plant to-day and see these compact "Safety-First" silent chain drives operating tube mills, ball mills, and other machinery will be a revelation to any one, and particularly to those who know the hazardous conditions prevailing in mills employing rope drives and the long, flapping leather belts.

This installation supplies evidence sufficient to convince the most skeptical that their fears were groundless, if there was ever a doubt in the minds of cement manufacturers regarding the adaptability of Link-Belt silent chain to their requirements, and its ability to withstand the hard service of mill operation. Here is a practical demonstration of what Link-Belt silent chain has done and what it can do in cement mills. It merits your consideration and adoption on the basis of superiority and service. Bear in mind that at the time this booklet goes to press these drives have been in operation without any replacement for more than two years.

Flexible as a belt, positive as a gear, more efficient than either—these twelve words tell the whole story of Link-Belt silent chain, the modern means of transmitting power. Link-Belt silent chain combines the advantages of belts and gears, and eliminates their disadvantages. It has rightfully earned its reputation—the ideal drive for cement mill machinery.

Link-Belt silent chain transmits power without slip or loss, on short or long centers, in hot, cold, damp, or oily places. Even the dust of cement mill service cannot reach the drive because of our patented oil-tight, dust-proof casings. It also means "Safety First," because all moving parts are completely encased.

It is not the purpose of this booklet to go into a discussion of the construction and varied uses of the Link-Belt silent chain drive, because these points are very completely described and illustrated in our price-list Data Book No. 125. It is sufficient to state that the patented pin-bushed-joint construction of the chain, shown on another page, is largely responsible for the success of the entire installation, because it maintains the high initial efficiency of the chain throughout its long service.

If you desire the complete facts regarding Link-Belt silent chain, we shall be glad to send an experienced engineer to show you what results you can expect in your own mill. A trial drive will convince you. Send for list of cement mills now using Link-Belt silent chain.—Booklet No. 253, "The Ideal Drive for Cement Mills."

We recently received a copy of the Link-Belt Wagon and Truck Loader Catalog No. 270, illustrating and describing the popular Link-Belt loaders which are winning such general recognition throughout the country

to-day as modern labor savers in the loading and screening of material such as coal, stone, sand, foundry refuse, etc.

The booklet is complete in detail, contains excellent illustrations, and says in part, concerning standard swiveling type fertilizer loader:

"Our experience has proved that the best results are obtained with wagon loaders when a machine is used which is designed to meet the particular requirements of the material handled. In other words, we do not believe in trying to use a coal loader for handling fertilizer. The work and conditions are too different. In the design of our fertilizer loader we have coöperated with the largest fertilizer interests in the country, and after a careful study of existing conditions under which the loaders would have to operate, we developed a standard machine, which, after fully trying out and perfecting, we offer as the most effective loader now made.

"The elevating medium is mounted on a swiveling base which swings through an arc of 50 degrees. This is sufficient to clear an ample path for the travel of the truck, and is particularly advantageous when working in narrow bins and close quarters where an ordinary type of wagon loader could not reach the material. The swiveling mechanism is power-driven through self-locking worm gears, which will hold the loader in any position desired, or the elevator may be swung from side to side while running.

"The elevating medium consists of two strands of combination Link-Belt with large malleable iron buckets, to which are attached hardened steel digging lips, not only on the front but also at each end, so that the elevator will dig into the material as effectively when swiveling as it will when backing into the pile. The buckets deliver into a hopper holding about 28 cubic feet, provided with a quick-acting gate for loading into carts or buggies. Thus the teams can load and depart without delay, and the loader can run steadily between trips, making it possible to use a smaller gang of men than under the old methods, as, with the loader, shoveling is almost entirely done away with.

"Our loader is self-propelled, and, in addition to the swiveling feature, has two speeds forward and two backward—a slow speed for working into the piles, and a faster speed for moving from place to place. The change in speeds, reversal of direction, swiveling, and engagement of the elevator, are all accomplished by means of friction clutches (doing away with any danger from shifting gears), so arranged that the elevator may be running while the loader is travelling and at the same time swiveling. This arrangement is practically fool-proof, and it is not possible for the operator to try to run his loader in two directions at the same time or at two speeds. The main gearing is cast steel with cut teeth, and is fully protected with housings, as are also the chain drives and motor.

"The front axle of the loader is arranged similar to standard automobile practice, with the wheels mounted

on knuckles, and with the axle free to adjust itself to any unevenness of the ground. The elevator is carried on a hinged frame which may be raised or lowered by means of a self-locking gear.

"At the side of the loader a platform is provided for the operator, and the starting switch and steering and operating levers are conveniently arranged so as to be under the complete control of one man.

"Specifications of the Swiveling Type Fertilizer Loader: Elevator—Double strand No. C-102B Combination Link-Belt with 18" by 8" malleable iron buckets at intervals of 16 inches. Capacity—30 cubic feet per minute. Drive—7½-horsepower motor of standard specifications, with necessary safety starting switch. Weight—8200 pounds. Speeds—75 feet and 5 feet per minute, forward or backward. Price—Upon application."

ENGINES

"Aëro Engines, with a General Introductory Account of the Theory of the Internal Combustion Engine," by G. A. Burls, is now in its fifth edition, although the first was published but nine months ago, which is sufficient justification for the purchase of this book by all ambitious mechanical engineers. The scheme of the work is to present, after some preliminary matter, one or two typical engines of each of the five classes: Horizontal, Radial, Diagonal, Vertical, and Rotary. The engines are illustrated and are described by the text in detail. The problems of equilibrium have been quite solved: it is now for the engine-builders to bring the aëroplane to perfection. Without a doubt this excellent work will help pave the way. There are seventy-five illustrations, including five large folding plates. The price is \$3 net.

A VALUABLE WORK

Andrew Alexander Blair, of Philadelphia, is the author of one of the really important American industrial scientific books; it is, as you know, "The Chemical Analysis of Iron." Upon the publication of the seventh edition, the following is quoted from *The Iron Age*: "The mere announcement that the seventh edition of Blair's work on the Chemical Analysis of Iron has been issued is sufficient, since it is a standard work in English." The history of how it has been kept the standard for twenty-eight years is of interest; here is a record of the successive editions:

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Copyright 1906 by Andrew Alexander Blair.
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With the publication of each new edition, the material has been brought thoroughly up to date and every effort has been made to make the presentment more lucid. The J. B. Lippincott Company now announces the publication in the fall of an eighth edition. The book and the author indeed have fine records.

PROCEEDINGS OF THE ENGINEERS' CLUB OF PHILADELPHIA

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VOL. XXXIV-7

JULY, 1917

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CONTENTS OF THIS ISSUE

	PAGE		PAGE
Officers, Directors and Standing Committees of Engineers' Club	302	Ninth National Conference on City Planning, Kansas City, Missouri	321
The New Club House	303	By B. A. HALDEMAN	
Officers and Directors-at-Large, 1917-'18	304	Military Aeronautics	324
Secretary's Notices	307	By MAJOR WILLIAM MITCHELL	
Special Meeting of the Board of Directors, June 5, 1917		Society of Automobile Engineers	331
Regular Meeting of the Board of Directors, June 12, 1917		Problems in Ignition Development	
Regular Meeting of the Club, June 19, 1917		By H. E. RICE	
Organization Meeting of the Board of Directors, June 19, 1917		Military Books for Engineers	336
Committee on Membership	312	American Society of Mechanical Engineers	337
D. ROBERT YARNALL, Chairman		The Engineering of Men	
Positions Open and Positions Wanted	312	By WILLARD BEAHAN	
Committee on Cooperation for National Defense . . 313		Illuminating Engineering Society	343
GEORGE R. HENDERSON, Chairman		Progress Notes: Incandescent Electric Lamps and Lighting	
Recent Development in V-Notch Weir Measurement 314		By UNIT RASIN	
Abstract of Paper Read before the Local Section A. S. M. E.		American Institute of Electrical Engineers	347
By D. ROBERT YARNALL and G. A. BINZ		American Society of Heating and Ventilating Engineers	347
The Ordnance Officers' Reserve Corps	320	Technology Club of Philadelphia	348

Permission is given to reprint any paper after its date of presentation, provided proper credit is given

Contributions of all kinds on all topics of interest to the members of the Engineers' Club are cordially invited. All matter for publication, including advertising copy, must be in the hands of the Editor by the 15th of the month for the issue of the following month.

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THE NEW CLUB HOUSE

TO make possible the absolutely necessary extension of the Club's quarters, the first step in a comprehensive program of development, a one-week campaign will be conducted during the latter part of July to obtain from the members of the Club a Building and Equipment Fund of \$75,000.

Ever since the close of the membership campaign, which added more than 1800 names to the Club's roster, the officers have been confronted with the imperative need of increasing the facilities of the Club, so as to meet adequately the ever-growing demands made upon them.

It was universally recognized by the members that larger and more commodious quarters were essential if the Club were to continue its growth and increase its influence in the community, as well as to care properly for its present membership. With such entire agreement as to the need of additional funds, the problem resolved itself into a question of ways and means.

Consideration was given by the Directors to a variety of plans, involving such features as a considerable increase in the annual dues, the sale of bonds, and the issuing of notes and mortgages. All those schemes were rejected, however, in favor of a more direct, business-like, economical and efficient plan which, the Board believes, will most quickly and most satisfactorily produce the desired results.

The method by which the Building and Equipment Fund will be raised is known as the short-term campaign. This twentieth-century method of obtaining money has operated successfully in hundreds of movements throughout the country (providing millions of dollars for colleges and universities, hospitals, clubs, and other institutions).

With some of the features of the short-term plan the members of The Engineers' Club were made familiar in the membership campaign of more than a year ago. Many other features, however, all with the single purpose of making the method still more productive of results, have been added.

Although the work of organization will require several weeks, the actual money-getting period will extend for only one week. During that week picked teams of volunteer workers, comprising some of the most active and best-known members of the Club, will call upon the other members for subscriptions to the fund. Each team will be headed by a captain, who will supervise the efforts of his fellow-workers.

Heading the entire movement will be a special executive committee. This committee, charged with general oversight of the work of the volunteer corps, will at the same time constitute a team and will help to swell the fund by obtaining pledges from certain members whose names the committee will select.

There will be no assignment of names to the various teams or to the individual members of those teams. Each team member will select for himself the names of the men on whom he will call for subscriptions. Once he has chosen the name of a prospect, no other worker can call upon that person. At the same time, no member of the Club will be called upon by any worker other than the one who has taken that member's name. This will eliminate all possibility of duplicated effort, thus saving the time and energy both of the worker and of the prospective subscriber.

The keynote of the whole campaign is the scientific division of labor which makes it impossible for any undue share of the burden to rest upon any individual member of the volunteer organization. Each worker is asked to give to the campaign only a relatively small part of his time and energy. The sum total of the worker's efforts, each doing his full share, means the successful outcome of the campaign.

Subscriptions to the fund will be payable in four semi-annual instalments, the first payment falling due August 15. This will make it possible for subscribers to pay their pledges over a period of slightly more than one and one-half years, instead of in cash.

To conduct the movement, the Board of Directors has engaged the services of George Ketchum, of Frederick Courtenay Barber and Associates, of New York City, an organization which has conducted scores of similar campaigns throughout the United States. Mr. Ketchum comes to Philadelphia from Terre Haute, Ind., where he has just completed a campaign for the Rose Polytechnic Institute, in which a total of \$385,000 was raised, although the original objective was only \$300,000.

Through the reports of President Carter and Mr. Swaab, chairman of the Club Development Committee, the members of The Engineers' Club have been made familiar with the detailed plans for the enlargement of the Club. Only general reference will be made here, therefore, to these numerous details.

The largest item in the total of \$75,000 which has been set as the goal for the campaign is the \$35,000 required for the purchase of the property at 1315 Spruce Street.

(Continued on Page 330)

ENGINEERS' CLUB OF PHILADELPHIA



JOHN A. VOGLESON
President



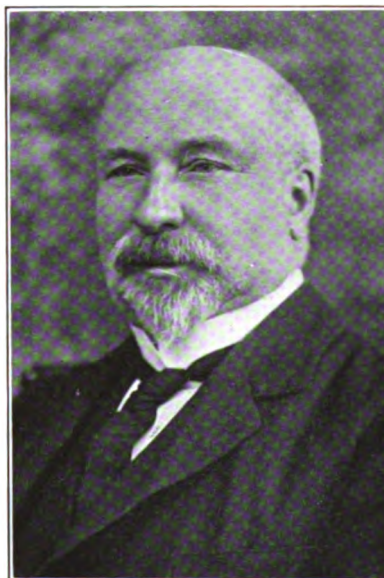
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Vice-President



JONATHAN JONES
Treasurer



ROBERT H. FERNALD
Director-at-Large



GEORGE R. HENDERSON
Director-at-Large



JOSEPH C. WAGNER
Director-at-Large



OFFICERS AND DIRECTORS-AT-LARGE



JOHN A. VOGLESON

President

Born at Columbiana, Ohio, in 1871, and was educated in the public schools of his native state, at Rose Polytechnic Institute and at Cornell, from which University he graduated in 1900, with the degree of Civil Engineer.

Mr. Vogleson began his engineering work as a student at Rose Polytechnic Institute, from where he went to California. For five years he was engaged in land surveying, railroad and irrigation work on the Pacific Coast. Returning East in 1897, he entered Cornell University and took his degree.

In 1901 he entered the service of the City of Philadelphia on the work of the improvement, extension and filtration of the water supply. With the exception of one year in the Philippine Islands as principal assistant engineer of the Department of Water Works and Sewer Construction at Manila, and one year with the Department of Water Supply, Gas and Electricity of New York City, he has devoted his engineering efforts to the City of Philadelphia.

In 1910 was appointed Chief of the Bureau of Health, which was the first instance of an engineer being made the executive officer of a Health Bureau of a large city, and he has continued in that capacity up to the present.

Mr. Vogleson has been a member of the Engineers' Club since 1904, and an officer of the Club since 1910. He is also a member of the American Society of Civil Engineers; Municipal Engineers of New York City; Engineers' Society of Pennsylvania; American Public Health Association; University Club; St. Augustine Commandery, No. 85, and Sigma XI.

WILLIAM C. L. EGLIN

Vice-President

Mr. William C. L. Eglin is the Second Vice-President and Chief Engineer of The Philadelphia Electric Company, and has been identified since 1889 with that company and its predecessors in the electric lighting field in Philadelphia. During this period the smaller electric lighting companies were consolidated into one large company, necessitating the standardization of power station equipment and distribution methods in order that a unified and economic system could be established throughout the city; this work, together with the erection of new plants as needed to furnish capacity for the rapidly expanding business of the company (notably the modern steam turbine station on the Schuylkill River at Christian Street), being designed and successfully accomplished under the direct supervision of Mr. Eglin.

Mr. Eglin is Past President of the National Electric Light Association; a Fellow of the American Institute of Electrical Engineers and one of its Past Vice-Presidents; and a member of the Board of Managers of The Franklin Institute of the State of Pennsylvania.

At the International Engineering Congress, held in Paris in 1900, Mr. Eglin served as the representative of the Engineers' Club of Philadelphia, and The Franklin Institute; and at the International Electrical Congress, held in St. Louis in 1904, he presented, by invitation, a paper on "Rotary Converters and Motor Generator Sets."

He has contributed to the technical press and to various associations a number of engineering papers, notably on the steam turbine.

He also served on the National Commission of Physicians and Engineers, appointed by the American Medical Association, to formulate rules for resuscitation from electric shock.

In addition to his membership in the Engineers' Club of Philadelphia, he is a member of the Engineers' Club of New York; Illuminating Engineering Society; American Electrochemical Society; American Society of Mechanical Engineers, and, as previously noted, a member of the National Electric Light Association, and a Fellow of the American Institute of Electrical Engineers. He is a member of the Union League and other prominent clubs of Philadelphia; also of the Navy League and the National Security League.

JONATHAN JONES

Treasurer

Born at Lewisburg, Pa., in 1882.

Educated at Chester High School and University of Pennsylvania (A.B., 1903; B.S., 1905; M.S., 1906).

Summers of 1903 and 1905, Pennsylvania Railroad Company field corps.

1906 to 1913, with McClintic-Marshall Construction Company, Pittsburgh and Pottstown, Pa., successively as draftsman, estimator, designer and engineer of Pottstown plant.

1913 to date, Assistant Engineer, Bureau of Surveys, Philadelphia, in charge of design and construction of bridges.

Member of American Society of Civil Engineers, American Society for Testing Materials, Franklin Institute, Engineers' Club of Philadelphia (Director, 1915-1916).

ENGINEERS' CLUB OF PHILADELPHIA

ROBERT HEYWOOD FERNALD

Director-at-Large

Born in Orono, Me., December 19, 1871.

Maine State College, 1892; Massachusetts Institute of Technology, 1892-'93; M. E. Case School of Applied Science, 1898; A.M., Columbia, 1901, Ph.D., 1902. Instructor, 1893-'96; Assistant Professor, 1896-1901, Case School of Applied Science; Professor of Mechanical Engineering, Washington University, 1902-'07; Professor of Mechanical Engineering, Case School of Applied Science, 1907-'12; Whitney Professor of Dynamical Engineering, University of Pennsylvania, 1912. Has conducted investigations for the United States Geological Survey and Bureau of Mines; prepared reports for these bureaus, etc. Engineer in charge Technologic Branch, United States Geological Survey, September 1, 1904, to July 1, 1910; Consulting Engineer, Fuel Division, Bureau of Mines, July 1, 1910. Contributed papers to technical journals and to reports United States Geological Survey and Bureau of Mines. Fellow A. A. A. S.; member American Society Mechanical Engineers (Chairman Gas Power Section, 1911; Chairman Philadelphia Section, 1915-'16); Manager, 1917; Chairman Meetings Committee, 1917; Society for Promotion of Engineering Education, American Society Testing Materials, Franklin Institute, Engineers' Club of Philadelphia, Philadelphia Chamber of Commerce, Sigma XI, Phi Kappa Phi, Overbrook Golf Club. President of Cleveland, Engineering Society, 1912. Writer on engineering topics.

GEORGE R. HENDERSON

Director-at-Large

Born at Philadelphia, Pa., in 1861. Educated at the Lauderbach Academy, graduating in 1876.

Served an apprenticeship with Pennsylvania Railroad at West Philadelphia shops, and entered the Altoona drawing office of same company in 1881, being made Assistant Chief Draftsman two years later.

From 1887 to 1899 was connected with the Norfolk and Western Railway as Assistant Shop Superintendent and Mechanical Engineer. After a short term with the Schenectady Locomotive Works as Assistant Mechanical Engineer, went to the Chicago and Northwestern Railway as Assistant Superintendent Motive Power, and in 1902 was appointed Superintendent Motive Power of the Atchison, Topeka and Santa Fé Railway.

From 1904 to 1910 conducted an office in New York as Consulting Mechanical Engineer, acting in this capacity for various corporations and railways in the United States, South America, the West Indies and the Philippines. The subsequent five years was associated with the Baldwin Locomotive Works as Consulting Engineer, and since 1915 has been engaged in independent consulting work in Philadelphia, with office at 1321 Walnut Street.

Member of Engineers' Club of Philadelphia; American Society of Mechanical Engineers; American Railway Master Mechanics' Association; Master Car Builders' Association; New York Railroad Club and Franklin Institute, being one of the managers of the latter.

As an author, has produced books and many articles and reports on railroad matters; his "Locomotive Operation," published over ten years ago, being used as a text-book in a number of prominent colleges.

JOSEPH C. WAGNER

Director-at-Large

1888, Degree of Civil Engineer, University of Pennsylvania; Lake Erie and Western Railroad, charge of field surveys, resurvey and mapping main line, Sandusky, Ohio, to Peoria, Ill., and Indianapolis to Peru, Ind.; assistant engineer on surveys for relocation and double-tracking main line, Norfolk and Western Railroad, Roanoke to Lynchburg, Va., also on New River Division, Bluefields to Glenside, W. Va.; since 1891, Department of Public Works, Bureau of Surveys, Philadelphia, as draftsman, assistant engineer, charge of sewer design and plans, and surveyor and regulator, Ninth District. Member of the American Society of Civil Engineers.

LEWIS H. KENNEY

Director-at-Large

Mechanical Engineer, Machinery Division, Navy Yard, Philadelphia.

Born in East Milton, Mass.

Received the degree of Bachelor of Science in 1899 and of Mechanical Engineer in 1906 from New Hampshire College. Shortly after graduation entered the Engineering Department of the Fore River Ship and Engine Company, Quincy, Mass. While on the Wm. Cramp and Sons Ship and Engine Company, prepared for the *Journal of the American Society of Naval Engineers*, at the request of the Secretary, a description of the official trials of the machinery of the U. S. S. *Pennsylvania* and *Tennessee*.

Instructor in steam engines and boilers, for evening classes, at Drexel Institute, for five years.

Member of the following societies: American Society of Mechanical Engineers; American Society for Testing Materials; American Society of Naval Engineers; Society of Naval Architects and Marine Engineers.

Secretary of the Engineers' Club of Philadelphia from February, 1915, to May, 1916, and chairman of the Committee on Papers from May, 1916, to June, 1917.

SECRETARY'S NOTICES

ABSTRACT OF MINUTES OF SPECIAL MEETING OF THE BOARD OF DIRECTORS.

JUNE 5, 1917

The meeting was called to order at 7.30 P.M. by President Carter, with Vice-Presidents Vogleson and Yarnall, Directors Wagner, Crampton, Bullens, George W. Barr, Past Presidents Taylor, Swaab and Ledoux, and Treasurer Irish in attendance. Vice-President Andrews, Directors Murray, Temple, R. M. Barr, and the Secretary were excused. Directors Liversidge, Gibson and Bachman were absent.

The subject of financing the purchase of the adjoining property was generally discussed by the Board.

Action: It was moved and carried that the Board issue a circular letter, on the Club letter-head, to the membership, explaining the scheme of financing the purchase of the proposed Club house extension; that the members be requested to make personal contributions, with no statement as to the amount expected nor date of payment specified; that \$50,000 was required, and that we have a membership of about 2200; that the letter be signed by the retiring President and the President-elect; that a committee, consisting of the Board as a nucleus, act as a follow-up committee to examine the returns the week after the letters have been sent out, and take such action as they deem best; and that the Board arrange for Mr. H. A. Stockly, who will take office July 1, to be at the Club, if possible, during the period this work is in progress.

The Board ruled that a printed return card, together with a stamped, addressed return envelope, be issued with the circular letter, the card to be made out in blank as to the amount to be paid and the time when the member would make payment.

Mr. C. M. Smith was introduced by the President, and he explained the general scheme that they had used in raising funds for various organizations, which consisted essentially of establishing committees of the membership, to be organized by his company; the members would be expected to devote a certain amount of their time to solicit funds; noonday luncheons should be held in order to provide the members an opportunity to exchange reports. In general, his scheme was very similar to that used in conducting our increase-of-membership campaign in November, 1915. He stated that, in general, they expected to receive five per cent. of the receipts for their services, but stated that under certain conditions this did not apply. The President requested Mr. Smith to submit to him a

definite proposition as to the conditions under which he would conduct the campaign for the Club to raise funds for the purchase of 1315 Spruce Street.

The Business Manager was instructed to send a night letter to Whitslar and Wells to learn under what conditions they would be willing to conduct a campaign to obtain funds for the purchase of 1315 Spruce Street.

The Business Manager was directed to send to the members of the Board, with the minutes of this meeting, a request that they submit at the regular meeting of the Board on June 12 eight or ten names of members whom they desired to have serve on their follow-up committee, each of the Directors to be chairman of such a committee.

In accordance with authority granted at the February 13 meeting of the Board, the President appointed the following to constitute a Committee on Increase of Membership, after consultation with Mr. Vogleson, the incoming president:

Clayton W. Pike, Chairman
Charles E. Bonine
Robert Farnham, Jr.
C. W. Thorn
F. H. Gilpin
Frederick J. Ryan
W. P. Dallett
J. D. Cassell
D. K. Bullens
B. B. Bachman
Unit Rasin

In accordance with authority granted at the May 8 meeting of the Board, the President appointed the following to constitute a Committee on Increase of Affiliated Societies, after consultation with Mr. Vogleson, the incoming president:

Carl Hering, Chairman
Harlan S. Miner
D. Knickerbacker Boyd

The Board considered the following subjects, which will be acted on at the Organization Meeting of the new Board:

That the Executive Committee provided for in our By-laws, Article IV, Section 26, consist of the following:

The President as chairman, the senior Vice-President, the Chairman of the following committees: Finance, House, and Publication, and the Secretary of the Club.

It was ruled that three members of the committee should constitute a quorum for the transaction of business.

ENGINEERS' CLUB OF PHILADELPHIA

It was considered that the Executive Committee should be given full power of the Board of Directors during the months of July and August.

The election of the Worcester Tech. Club to affiliated membership establishes a vacancy in the Directors-at-large.

Action: Mr. Joseph C. Wagner was elected to fill the vacancy.

The meeting adjourned at 8.30 P.M.

LEWIS H. KENNEY,
Assistant Secretary.

ABSTRACT OF MINUTES OF REGULAR MEETING OF THE BOARD OF DIRECTORS

JUNE 12, 1917

The meeting was called to order by President Carter at 7.30 P.M., with Vice-Presidents Yarnall and Andrews, Directors Wagner, Crampton, Bullens, George W. Barr, Presidents Taylor, Swaab and Ledoux, Secretary Fernald, and Treasurer Irish in attendance. Vice-President Vogleson, Directors Liversidge, Gibson, Temple, Murray, and Robert M. Barr were excused. Directors Bullens and Bachman were absent.

The minutes of the following meetings, as issued to the Board, were approved:

Regular Meeting, May 8, 1917.

Special Meeting, May 15, 1917.

Special Meeting, June 5, 1917.

REPORT OF THE PRESIDENT

The President read a letter from Mr. C. M. Smith, of Frederick Courtenay Barber and Associates, campaign managers, outlining their method of conducting a campaign for raising funds. Mr. Smith and Mr. Ketchum were present to verbally explain their method of conducting campaigns.

Action: The President was authorized to appoint the following committee to confer with Mr. Smith, with authority to enter into a contract with this firm:

Emmett B. Carter
D. Robert Yarnall
Lewis H. Kenney

REPORT OF THE SECRETARY

The following information was obtained from affiliated societies in connection with the preparation for publication of the 1917 Directory:

A. S. C. E.

President, Samuel T. Wagner (term to expire October 2, 1917).

Secretary, C. W. Thorn.

Representative on our Board, Samuel T. Wagner.

Representative on our Committee on Meetings, W. L. Stevenson.

Representative on our Committee on Public Relations, Fred C. Dunlap.

A. S. M. E.

President, Lewis F. Moody.

Secretary, John P. Mudd.

Representative on our Board, Lewis F. Moody.

Representative on our Committee on Meetings, Joseph A. Steinmetz.

Representative on our Committee on Public Relations, Strickland L. Kneass.

Associate Editor of PROCEEDINGS, John P. Mudd.

S. A. E.

President, John W. Watson.

Secretary, A. K. Brumbaugh.

Representative on our Board, B. B. Bachman.

Representative on our Committee on Meetings, Nelson S. Pringle.

Representative on our Committee on Public Relations, William H. Palmer, Jr.

Associate Editor of PROCEEDINGS, B. B. Bachman.

I. E. S.

President, Walton Forstall.

Secretary, Unit Rasin.

Representative on our Board, Walton Forstall.

A. S. H. V. E.

President, George W. Barr.

Secretary, George Boon.

Representative on our Board, George W. Barr.

Representative on our Committee on Meetings, George Boon.

Associate Editor of PROCEEDINGS, A. C. Edgar.

Technology Club (M. I. T.)

President, H. A. Terrell.

Secretary, G. W. Barnwell.

Representative on our Board, D. K. Bullens.

Representative on our Committee on Meetings, H. A. Terrell.

Representative on our Committee on Public Relations, H. L. Moody.

Associate Editor of PROCEEDINGS, G. W. Barnwell.

Worcester Tech. Club

President, George A. Denny.

Secretary, Robert M. Barr.

Representative on our Board, Robert M. Barr.

Representative on our Committee on Meetings, W. P. Dallett.

Representative on our Committee on Public Relations, George A. Denny.

Associate Editor of PROCEEDINGS, Robert M. Barr.

SECRETARY'S NOTICES

A letter was read from the Engineers' Country Club, at Roslyn, Long Island, N. Y., announcing the opening of their new club house on June 27, and asking for a list of names and addresses of individuals to whom they may send cards of invitation.

Action: Secretary instructed to send them a copy of our Year Book.

REPORT OF THE BUSINESS MANAGER

The Treasury Department has been requested to provide copies of Department Circular No. 78 and the 1917 Liberty Loan form No. 1 for distribution to our members. These have been issued with the notice of our June meeting.

The sample of Club emblem submitted by the jewelers has finally been approved, and they have been authorized to proceed with the contract.

Contract has been placed with the U. S. Audit Company to audit the books quarterly, on the following dates:

June 30, 1917	December 31, 1917
September 30, 1917	March 31, 1918

The Board of Directors, on June 13, 1916, adopted certain rules for the government of the Board of Directors, its officers and committees. Those rules were applicable to the By-laws in operation at that time. The present By-laws will require a revision of these general rules.

Action: Matter referred to the new board, with the suggestion that a committee be appointed for revision of these rules.

I understand that many clubs are extending the privileges of their club house to commissioned officers of the regular army and navy; furthermore, that clubs extending these privileges are registered with the Army and Navy Club in Washington, and that club, in recognition of this arrangement, will grant temporary membership to the members of any of these clubs. The applicant for temporary membership will file an application in the prescribed form. It is recommended that the Club extend the privileges of the Club House to commissioned officers in the regular army and navy.

Action: Recommendation approved.

Mr. L. H. Kenney, the assistant secretary, tendered his resignation.

Action: Resignation accepted as of June 12, 1917. Mr. H. A. Stockly was elected to the office of assistant secretary for the term ending June 30, 1917.

In accepting Mr. Kenney's resignation as assistant secretary, it was ordered that it be made a part of the minutes and transmitted to Mr. Kenney that the Board desires to commend him for his invaluable services and his unending interest in the Club, and to express to him their thanks and appreciation.

REPORT OF THE TREASURER

The Treasurer presented a statement of the financial condition of the Club.

Action: Report accepted.

REPORT OF THE COMMITTEE ON FINANCE

The Secretary presented the report of the Committee on the financial condition of the Club, giving the balances as of May 31 on the various appropriations.

Action: Report accepted.

REPORT OF THE COMMITTEE ON HOUSE

The Chairman presented a report which was accepted.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The Committee presented a report, recommending that the following be elected:

Active: Harold S. Bell
William Boyd
Forest G. Brown
Joseph G. Crosby
Franklin T. Morgan
Louis B. Smyser
Walter Wood

Action: Recommendation approved.

REPORT OF THE COMMITTEE ON PAPERS

The Committee on Award of Junior Prize has adjudged Mr. Wilmer Z. Kline winner of the prize, the subject of the paper being "Philadelphia Bridges—Past, Present, and Future."

The Juniors held a dinner at the Club House, Tuesday evening, May 28. Mr. S. M. Swaab was the principal speaker of the evening, and presented an address on "Some Random Observations on the Relation of the Junior Member to the Engineers' Club." Following the address, several members were called upon for speeches. Some of the views presented by them are as follows:

That it might be advisable to establish a Junior organization with a Chairman selected by the Juniors, a Junior Papers Committee, and a Junior Executive Committee; that the Juniors would become interested if they were assigned specific duties, and that this would result in a larger attendance at the meetings; that it might be advisable to make some attempt to interest the Junior and Senior students of the technical colleges in Philadelphia and allow them certain privileges at the Club, possibly by providing for the student membership on payment of a nominal fee; that these meetings would stimulate interest and develop sociability among the Junior members; and that Juniors would feel that they were members of the Engineers' Club and not merely "junior engineers" who have no voice or vote; and that the Juniors desire that they continue their meetings next year, either by a committee of their own appointment or otherwise.

Doctor Boehm, who has been chairman of the Junior meetings this year, and who made all arrangements, stated that his object in arranging the meetings was to bring the Junior members together and to give them an opportunity to discuss papers under circumstances where they would feel perfectly free to do so, and for this reason attendance at the meetings was limited to Junior members and to guests they might invite.

In order that work might not be too arduous, the men were requested to prepare papers which would re-

ENGINEERS' CLUB OF PHILADELPHIA

quire only twenty to twenty-five minutes for presentation, and two or three papers were presented at each meeting. Doctor Boehm stated that, in his opinion, excellent papers had been presented during the past year, and that some of them had been published in the PROCEEDINGS and others would be published at a later date. The doctor volunteered to assist in developing the Junior meetings next year, and promised to take up the subject with the President-elect.

Action: Report accepted, and the suggestion therein referred to the new Board for action.

The meeting adjourned at 9.50 P.M.

ROBERT H. FERNALD,
Secretary.

ABSTRACT OF MINUTES OF THE REGULAR MEETING OF THE CLUB.

HELD TUESDAY EVENING, JUNE 19, 1917

The meeting was called to order by President Carter at 8.30 P.M. About fifty members and guests were in attendance.

The minutes of the Special Meeting of May 4 and the Thirty-eighth Annual Meeting of May 15 were approved as printed in the PROCEEDINGS.

The Board of Directors elected, at its last meeting, the following to membership: 8 Active.

The President introduced Mr. H. A. Stockly, who had recently been appointed secretary of the Club; also Mr. George Ketchum, of Frederick Courtenay Barber and Associates, who will conduct the Club's campaign to raise funds for the purchase and equipping of the adjoining property, No. 1315 Spruce Street.

The paper of the evening, "Philadelphia Bridges—Past, Present, and Future," was presented by Wilmer Z. Kline, winner of the Junior Prize. The paper was discussed by Messrs. Quimby, Nichols, Webster, and Philips.

The meeting adjourned at 9.50 P.M.

ROBERT H. FERNALD,
Secretary.

ABSTRACT OF MINUTES OF ORGANIZATION MEETING OF THE BOARD OF DIRECTORS

JUNE 19, 1917

The meeting was called to order at 7 P.M., with President Vogleson, Vice-Presidents Yarnall, Andrews and Eglin, Directors Fernald, Henderson, Wagner, Robert M. Barr, Past President Carter and Treasurer Jones in attendance. Past Presidents Swaab and Ledoux were excused. Directors Hayward, Moody, Wagner, Forstall, Bullens, Bachman, and George W. Barr were absent. Mr. W. P. Taylor was also present.

It was decided to announce that the Club will need \$75,000 for the purchase of the adjoining property, 1315 Spruce Street, and that anything raised above that figure would apply to the improvement of the present property, or the reduction of the debt on the present property.

It was the sense of the meeting that the proper officers enter into an agreement with the Girard Trust Company for a sixty-day option on the property, 1315 Spruce Street, not to exceed \$1000, the option money to apply on the purchase price.

REPORT OF THE PRESIDENT

The By-laws, Article IV, Section 12, provide for the appointment of a secretary at the organization meeting.

Action: Mr. H. A. Stockly was appointed Secretary for one year, beginning July 1, 1917.

The President announced the appointment of the following Standing Committees and Tellers:

Committee on By-laws:

J. F. Stevens, Chairman
R. H. Fernald
John C. Trautwine, Jr.

Robert M. Barr
George W. Barr

Committee on Finance:

Wm. C. L. Eglin, Chairman
Jonathan Jones
J. F. Murray

W. M. Irish
(Fifth member to be appointed by Mr. Eglin.)

Committee on Membership:

D. Robert Yarnall, Chairman
Harold Goodwin, Jr.

(Additional three members to be appointed by Mr. Yarnall.)

Committee on Meetings:

R. H. Fernald, Chairman
Lewis H. Kenney
J. A. Steinmetz (A.S.
M.E., I.E.S., A.I.E.E.)
W. L. Stevenson (A.S.
C.E.)

W. P. Dallett (W.T.C.)
H. A. Terrell (M.I.T.)
N. S. Pringle (S.A.E.)
George Boon (A.S.H.
V.E.)

Committee on Papers:

Lewis H. Kenney, Chairman
R. H. Fernald

W. M. Boehm
Wm. Pool Parker
H. F. Sanville

Committee on Public Relations:

George R. Henderson, Chairman
Emmett B. Carter
Edgar Marburg (A.I.E.
E., I.E.S.)
Strickland L. Kneass
(A.S.M.E.)
Fred C. Dunlap (A.S.
C.E.)

H. L. Moody (M.I.T.)
W. H. Palmer, Jr.
(S.A.E.)
John D. Cassell (A.S.H.
V.E.)
George A. Denny (W.
T.C.)

Committee on Publication:

Jos. C. Wagner, Chairman
S. M. Swaab

J. W. Ledoux
John P. Mudd
Lewis H. Kenney

Committee on House:

J. H. M. Andrews, Chairman
H. P. Gant

Robert M. Barr
Herbert Rice
M. M. Price

Tellers of Election:

George E. Crofoot, Chairman
John P. Mudd

Harold Goodwin, Jr.
Charles F. Puff, Jr.
John S. Ely

SECRETARY'S NOTICES..

The President also announced the reappointment of the following Committees:

Committee on Increase of Affiliated Societies:

Carl Hering, Chairman	D. Knickerbacker Boyd
Harlan S. Miner	

Committee on Increase of Membership:

Clayton W. Pike, Chairman	J. D. Cassell
Charles E. Bonine	D. K. Bullens
F. H. Gilpin	B. B. Bachman
Frederick J. Ryan	Unit Rasin
W. P. Dallett	(Two additional members to be appointed.)

Trustees of the Bond Redemption Fund:

Henry Leffmann, Chairman	Edgar Marburg
	Edwin F. Smith

Committee on Coöperation for National Defense:

George R. Henderson, Chairman	(Additional members to be appointed.)
Emmett B. Carter	

Action: Appointments ratified.

The following Executive Committee, whose appointment was made at the June 5 meeting of the Board, was ratified:

J. A. Vogleson, Chairman	J. H. M. Andrews
D. Robert Yarnall	H. A. Stockly, Secretary of the Committee
Jos. C. Wagner	
Wm. C. L. Eglin	

Three members of the Committee shall constitute a quorum for the transaction of business, and the Committee will have all the powers of the Board during the months of July and August.

The election of Mr. Joseph C. Wagner as Director-at-large for a period of one year, beginning July, 1917, was ratified.

Under the new organization, the Secretary not being a member of the Board, a vacancy occurs in the Directors-at-large, which it is necessary to fill, in accordance with Article IV, Section 7 of the By-laws.

Action: Mr. Lewis H. Kenney unanimously elected to fill the vacancy for a period of one year, beginning July, 1917.

Copy of the Rules governing the Board of Directors, its Officers and Committees, as revised by the Business Manager to conform with the new By-laws, recently adopted, was presented.

Action: The Rules, as revised, were adopted by the Board.

Contract with Frederick Courtenay Barber and Associates, for conducting the campaign to raise funds, has been signed.

Action: Contract ratified, subject to revision of the amount to be raised to read \$75,000, instead of \$65,000.

The President stated that plans were in progress whereby it is hoped that means would be effected by which the Club can be made an effective agent in the problem of national defense. He stated that most excellent work had been performed by the Committee on Coöperation for National Defense, and it was thought that the opportunity for the Club lies in carrying this work still further forward, and the card index of members available for national defense be made effective.

The President presented a letter from Mr. S. M. Swaab with regard to the option on the property No. 1315 Spruce Street, this matter having been taken care of at the beginning of the meeting.

The President presented a letter from Mr. A. C. Wood, a member of the Club, in regard to the taking of quarters in the new Longacre Building, but stated that he did not find the proposition feasible.

It was the sense of the Board that the Executive Committee is vested with full power to act in all matters in connection with the campaign for the Building and Equipment Fund, and that the question of the period over which subscription may be extended be left to the Campaign Executive Committee to settle with the Barber Company.

Mr. Carter stated that, in his opinion, the Campaign Executive Committee should be appointed by the old Board, to hold over until the close of the campaign.

REPORT OF THE SECRETARY

A report from Mr. H. C. Heaton on the State College Convention held June 12, 1917, was presented.

Action: Report accepted with thanks.

Copy of revised application form for membership, to conform with the new By-laws, was presented. This application form was approved by the Committee on Membership.

Action: Board approved revised application form.

The President stated that it was his hope that the cordial coöperation that has been maintained in Mr. Carter's administration would be continued, and that the present Board, as it assumes its duties, will pull as one team, and would exert its best efforts for carrying forward the work for the year 1917-1918.

The meeting adjourned at 8.10 P.M.

ROBERT H. FERNALD,
Secretary.



COMMITTEE ON MEMBERSHIP

D. ROBERT YARNALL, CHAIRMAN

CANDIDATES FOR MEMBERSHIP

Members having knowledge of the candidates are invited to submit to the Committee on Membership before September 3 a confidential expression of opinion as to the eligibility of the candidates; all communications to be addressed, "Chairman of the Committee on Membership, Engineers' Club, Philadelphia," marked "Confidential."

All applications are on file at the Club and can be referred to by any member.

CARL C. BAILEY

118 Grandview Road, Ardmore, Pa.
Civil Engineer, Remington Arms Company of Delaware.
Proposed by Robert S. McConnell, Jacob L. McConnell, and
A. W. Keane.

CHARLES CLEES, JR.

5400 Whitby Avenue, Philadelphia, Pa.
Manager, Edward Valve and Manufacturing Company.
Proposed by Frank H. Schaefer, M. C. Gillett, and Raymond
E. Jones.

GEORGE H. DICKEL, JR.

234 N. 23d Street, Philadelphia, Pa.
Secretary, Cyrus Borgner Company.
Proposed by T. Elmer Moon and Horace A. Smith.

MAURY POLK GREGG

418 South Broad Street, Philadelphia, Pa.
Marine Engine Draftsman, Chester Shipbuilding Corporation.
Proposed by Charles Elcock and William M. White.

EDWARD B. HAROLD

Finance Building, Philadelphia, Pa.
District Sales Manager, Hercules Cement Corporation.
Proposed by Percy H. Wilson, John B. Lober, and E. F. Cobb.

HARRY THOMAS JONES

5113 Chester Avenue, Philadelphia, Pa.
Manager of Valve Department, The Fairbanks Company, Philadelphia, Pa.
Proposed by W. T. Kershaw and George McKay, Jr.

ROGER M. NETHERLAND

Care of Public Works Office, League Island, Philadelphia, Pa.
Construction Engineer and Superintendent for The Foundation
Company.
Proposed by W. D. Thomas and Moriz Bernstein.

FRANK SUTCLIFFE

Care of John Wood Manufacturing Company, Conshohocken, Pa.
General Manager, John Wood Manufacturing Company; Proprietor Albion Foundry.
Proposed by Joseph A. Steinmetz and Fred J. Ryan.

FRANK WEBSTER

1043 Drexel Building, Philadelphia, Pa.
Vice-President, R. H. Beaumont Company.
Proposed by R. H. Beaumont and A. C. Seibert.

SITUATIONS VACANT

Wanted—Engineers experienced in construction work supervision. Apply Engineers' Club, No. 150-A.

Young man wanted to inspect overhead lines. Electrical experience desirable, but not absolutely necessary. Apply Engineers' Club, No. 151-A.

Combustion engineer wanted—familiar with large steam plants—experience in efficiency work. Apply Engineers' Club, No. 152-A.

POSITIONS WANTED

Technical graduate, with experience as draftsman, master mechanic, and mechanical engineer, wishes position with manufacturing concern in or around Philadelphia. Apply Engineers' Club, No. 145.

Superintendent or general foreman of construction work—bridges, grading, roadwork, etc. Apply Engineers' Club, No. 146.

Mechanical Engineer—University of Pennsylvania, 1912. Several years' experience in shop, drawing-room, office, and field. Prefers position outside drawing-room. Personal interview. Best references. Apply Engineers' Club, No. 147.

Engineer and architect—Design, testing, inspecting, and superintending of structures. Apply Engineers' Club, No. 149.

Mechanical engineer—Three years' experience in construction and design. Apply Engineers' Club, No. 150.

Civil engineer, college graduate, desires a position in construction work for building development. Age, 33 years. Several years' experience. Good references furnished. Apply Engineers' Club, No. 154.

Mechanical engineer, University of Pennsylvania, 1910, at present employed, is seeking position in which six years' experience in selling and sales management, along engineering lines, can be used to advantage. Has also worked in shop and drawing-room. Excellent references. Apply Engineers' Club, No. 155.

Young man, selling power plant equipment for several years, desires a good account in Philadelphia and adjacent territory. Apply Engineers' Club, No. 156.

COMMITTEE ON COÖPERATION FOR NATIONAL DEFENSE

GEORGE R. HENDERSON, CHAIRMAN

MEMBERS OF ENGINEERS' CLUB WHO HAVE BEEN CALLED INTO SERVICE IN THE ARMY OR NAVY OF THE UNITED STATES AS OF JUNE 20, 1917

NAME	RANK	CORPS	LOCATION
ASPLUNDTH, E. T.	Captain	Engineers' Officers' Reserve	Belvoir, Va.
BROADHEAD, ALEX.		"B" Company, Engineers' Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
CACCAVAJO, JOS.	Captain	Engineers' Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
CRAMPTON, G. S.	Major	Medical Corps, National Guard	Fort Benjamin Harrison, Ind.
FULWEILER, J. E.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
GWILLIAM, MARK R. M.	1st Lieutenant	Officers' Reserve Corps	Fort Oglethorpe, Ga.
HALL, W. A.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
HOLLENBACK, E. E.	Major	1st Pennsylvania Infantry, National Guard	Columbia, Pa.
LAWRENCE, G. E.	Lieutenant J.G.	Naval Coast Defense	Philadelphia Navy Yard
LAWSON, T. W.	Lieutenant	Supply Co., 1st Penna. Infantry, Nat'l Guard	Philadelphia
MCCORD, J. B.	Captain	Ordnance Officers' Reserve	War Department, Washington, D. C.
MYERS, W. T.		Fort Niagara Officers' Training Camp	Fort Niagara, N. Y.
NEWLIN, E. M.		Fort Niagara Officers' Training Camp	Fort Niagara, N. Y.
NIXON-MILLER, W.	Captain	Engineers' Officers' Reserve	Belvoir, Va.
O'CONNOR, C. P.	Captain	Engineers' Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
REED, R. W.	Private	"E" Company, Engineers' Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
RITCHIE, J. M.	Captain	Quartermaster's Officers' Reserve	
RIDGWAY, J. J.		Company 7, Officers' Reserve Training Corps	Fort Niagara, N. Y.
SHUSTER, W. H., JR.		Fort Niagara Officers' Training Camp	Fort Niagara, N. Y.
TILLSON, P. E.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
WILD, H. J.	Captain	Engineers' Officers' Reserve	Belvoir, Va.
WILSON, L. B.	Private	Company I, 1st Pennsylvania Infantry	Rockville, Pa.
WORTH, J. G.	Captain	Quartermaster's Officers' Reserve	

Important information concerning The Ordnance Officers' Reserve Corps on Page 320

REQUEST FOR INFORMATION

THE COMMITTEE REQUESTS THAT THE MEMBERS OF THE CLUB INFORM THE COMMITTEE OF THEIR ADMISSION TO THE MILITARY OR NAVAL SERVICE.

THE COMMITTEE WOULD ALSO BE PLEASED TO RECEIVE SUGGESTIONS FROM MEMBERS WHO HAVE ENTERED THE SERVICE. PLEASE ADDRESS COMMUNICATIONS TO THE COMMITTEE ON COÖPERATION FOR NATIONAL DEFENSE.

RECENT DEVELOPMENT IN V-NOTCH WEIR MEASUREMENT

ABSTRACT OF PAPER READ BEFORE THE LOCAL SECTION A.S.M.E., APRIL 24TH, 1917

By D. ROBERT YARNALL AND G. A. BINZ

AFTER briefly reviewing the circumstances which led to the development of the Lea V-notch meters in America by the Yarnall-Waring Company, the speaker drew attention to the importance of measuring boiler feed water continuously by reference to the diagram shown in Fig. 1. Coal, it will be seen, forms by far the largest portion of the boiler-room costs, and it is obvious that a comparison of the pounds of coal consumed with the pounds of water evaporated will furnish most valuable information regarding the efficiency of the plant in question. As a matter of fact, a plant where a recording feed-water meter is installed is run under continuous test conditions.

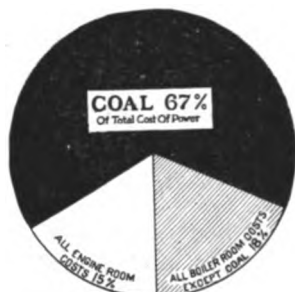


FIG. 1.—DIVISION OF COSTS IN THE AVERAGE POWER PLANT.

Weirs of various types have been widely known to hydraulic engineers for a great many years, and employed by them for the measurement of the flow of streams and large volumes of flowing water. In Fig. 2 is shown a comparison of the flow curves obtained when using various types of weirs. The rectangular form is most popular for very large flows at a more or less constant rate. It was found less suitable for boiler-feed measurements, firstly, because different coefficients have to be used for every different ratio of width to height, and, secondly, because the rectangular notch furnishes very small motive power at low rates of flow. The V-notch disposes of both these objections. For all practical purposes its accuracy is the same at all rates of flow. The curve also shows that, at low rates of flow, the head increases rapidly for small increments in volume. The V-notch is therefore an ideal weir for boiler-room measurements, and has become universally adopted for this purpose.

Measurements of flow by means of the V-notch are based upon the well-known formula:

$$Q = K \times H^{\frac{5}{2}},$$

in which

Q = quantity flowing in a unit of time.

K = a constant.

H = height in inches of liquid flowing through weir.

The flow, therefore, is not directly proportional to the head, and some compensating device must be embodied in the recording mechanism, if, as is desirable, the recording member shall travel equal distances on the chart for equal increments of flow. Various methods have been proposed and developed at different times with this object in view, and a few of the more important ones will be briefly described below. The illustrations are reproduced by kind permission of *Power*. These various methods might be divided into the following groups:

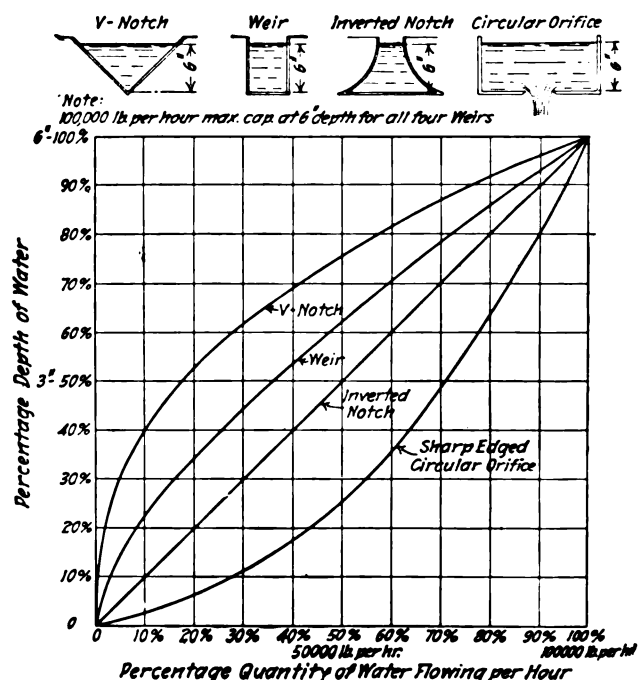


FIG. 2.—COMPARISON OF CURVES OBTAINED WHEN USING DIFFERENT WEIRS.

A. Instruments which use a plain float and employ some intermediate method for correcting the travel of the pen on the recording chart.

B. Instruments in which the compensation has been either worked directly into the shape of the weir or where a float of special construction is used to secure equal rise for equal increments in flow.

C. Instruments operated electrically.

D. Instruments which weigh the liquid.

Commencing with group A, probably the forerunner of the best-known V-notch meters was that designed by James A. Gardner and built by the firm of Glenfield & Kennedy, Ltd., of Kilmarnock, Scotland (Fig. 3). The idea underlying the construction of this meter is as follows: The length of a pendulum H , which controls the escapement of the integrating device, is made to vary as

the $5/2$ power of the head of liquid in the notch. This is accomplished by causing the suspension carriage *E* of the pendulum to ride on a cam *D*, made to rotate as the float rises and falls. The device is so adjusted that there is no movement of the integrator when the float is at zero. As the float rises the pendulum is shortened and the clock escapement, which it controls, runs more rapidly. No chart record is provided. Great delicacy is probably the principal disadvantage of this ingenious design.

Next under this group stands the Lea meter (Fig. 4), which will be described in greater detail below. Suffice it to say here that with this meter a cam is interposed between the float and the recording chart. This cam is in the form of a drum carrying a screw thread with variable pitch so calculated that the pen will be caused to travel equal distances on the chart for equal increments of flow.

Another meter which uses this method of correction, but employs a spiral groove cut upon the surface of a flat disk, is the Cochrane (Fig. 5). The float is suspended from the cord *S* wound around drum *B* and counterbalanced by weight *W*. The cam disk is mounted on the

same shaft *B* and rotated when the float rises or falls, thus moving the carriage *D* to which the recording pen and integrator are attached.

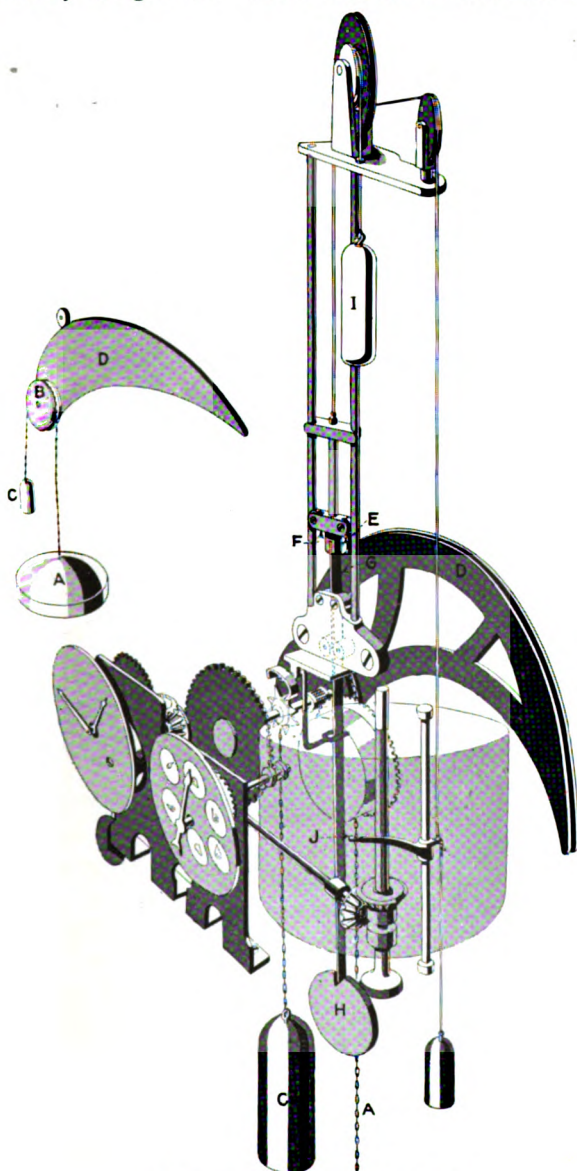


FIG. 3.—THE GARDNER METER.

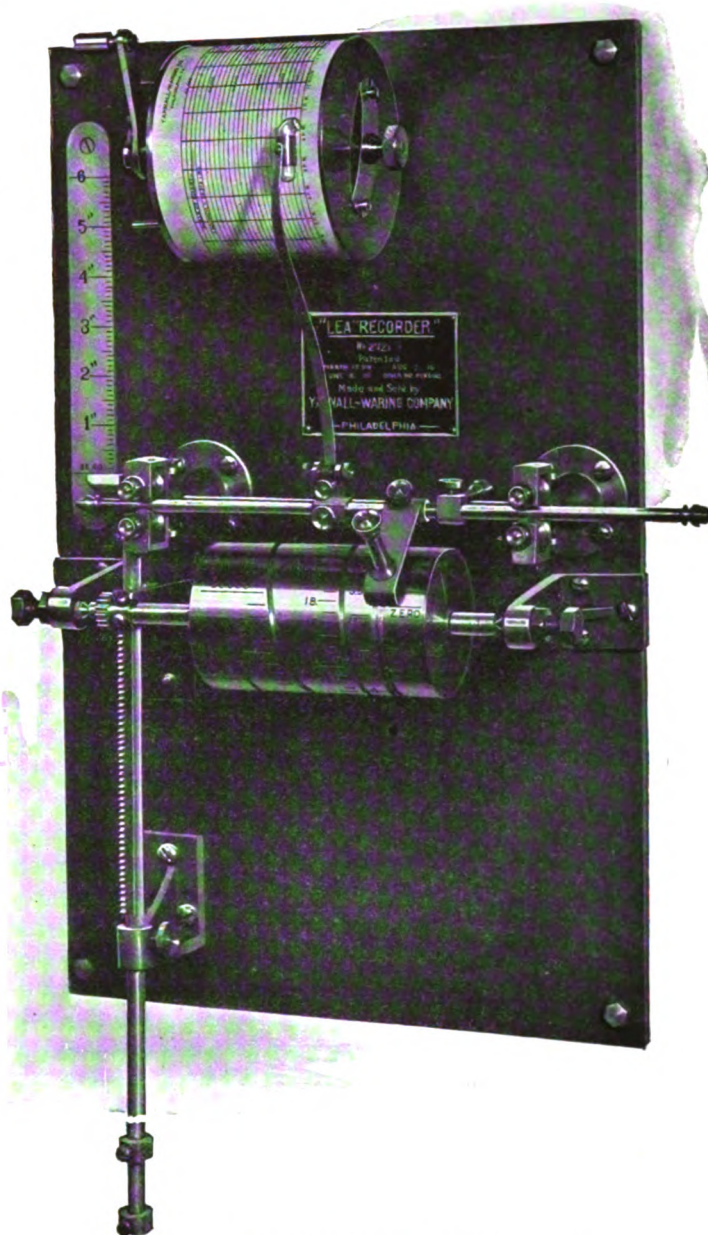


FIG. 4.—RECORDING MECHANISM OF LEA METER.

We now come to the group where the correction necessitated by the fact that the quantity of water flowing through a V-notch is as the $5/2$ power of the head is made directly by shaping the weir or the float employed.

One of the earliest methods of this kind is the weir designed by and named after Wilfred Yorke, an Englishman (Fig. 6). This weir is so designed that the area varies as the square root of its height, and therefore the quantity flowing through this weir varies directly as the head. It has been found in practice that this weir cannot be shaped in accordance with calculated curves, as varying contracting effects and other disturbing factors have to be taken into consideration. It is therefore made in accordance with empirical determinations.

The same principle is employed in a weir formerly manufactured by the Kennicott Company, of Chicago (Fig. 7). Here the water falls through a specially shaped slot, and it will be seen that for equal divisions *A, B, C, D,*

is successively changed by causing the lower conical portion of the float to displace a varying quantity of mercury contained in *M*. In this way the effective weight of the compound float system is successively decreased in such a

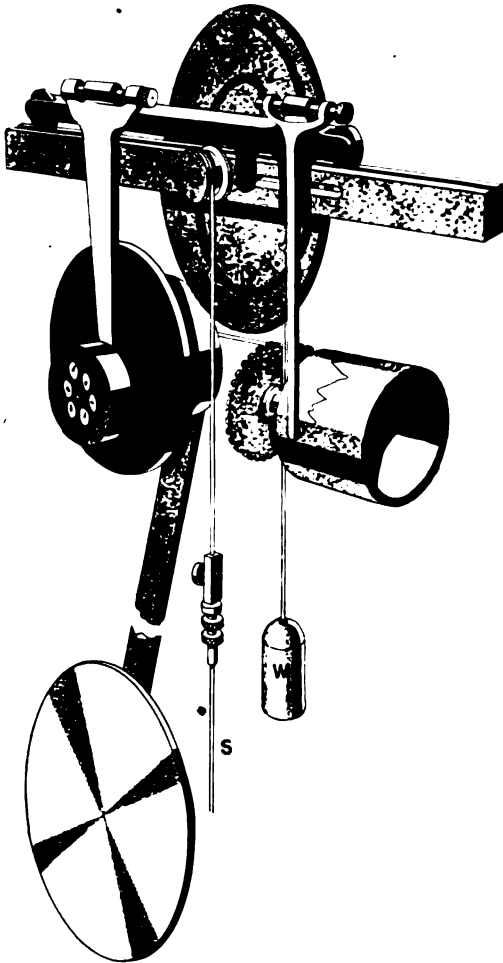


FIG. 5.—THE COCHRANE RECORDER.

etc., of head the area added for the passage of water to the interior of the weir grows progressively smaller as the head increases. Both these weirs were found in practice to show considerable inaccuracy at very low flows.

Of meters in which the compensation to the chart reading is obtained by employing a specially shaped float, probably the earliest was invented by Mr. J. W. Ledoux and built by the Simplex Valve and Meter Company, of Philadelphia (Fig. 8). In this meter the buoyancy of the float

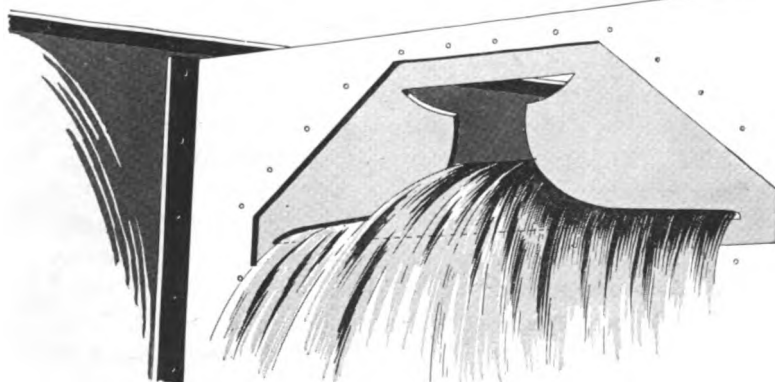


FIG. 6.—THE YORKE INVERTED WEIR.

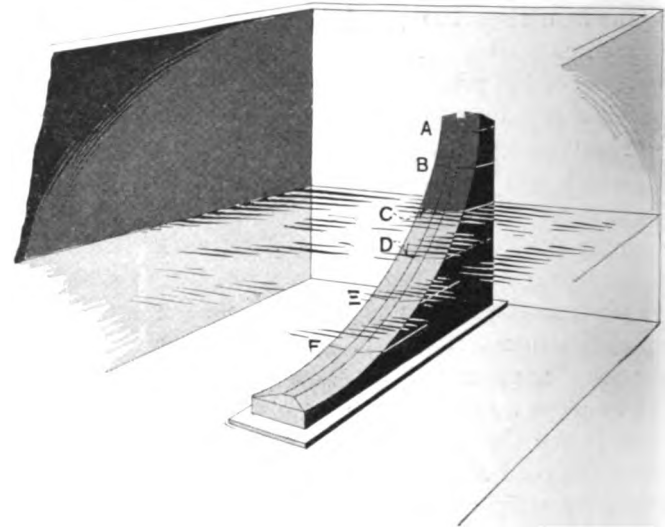


FIG. 7.—THE KENNICOTT CYCLOIDAL WEIR.

way that the float will travel equal distances for equal increments in flow.

Another form employing this principle of changing buoyancy is employed in the ingenious design due to Mr. E. G. Bailey, of Boston (Fig. 9). Here two displacement bodies are used suspended on opposite ends of a scale beam pivoted on knife edges at *C*. The two bodies are so adjusted that they rest on the surface of the water when no water is flowing through the notch. In this position both bodies are of equal area, displace equal volumes of water, and are therefore balanced. The cross-section of one of the bodies increases upward, whereas that of the other diminishes. As the water rises on them they therefore displace different volumes of water, and one will sink lower than the other before equilibrium is restored. A turning motion of the scale beam results, which is transmitted to the recording chart. By shaping the contours of the two bodies, their motions are made to conform exactly with the $5/2$ power curve-of-flow.

Of electrically operated

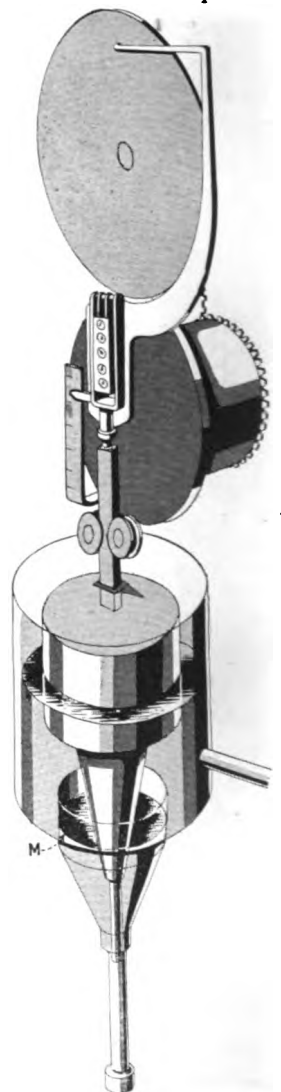


FIG. 8.—THE SIMPLEX RECORDER.

RECENT DEVELOPMENT IN V-NOTCH MEASUREMENT

devices, only one has come under our notice; namely, that proposed in 1914 by Professor Rateau, the inventor of the Rateau turbine (Fig. 10). The head, in this case, is measured by the difference in level in a mercury

U-tube. The leg in which the lower level occurs carries a resistance element, such as a high resistance wire wound upon an insulator. This element is made part of an electric circuit in which is included a special differential millivoltmeter. As the mercury rises and falls in

the leg of the U-tube, more or less of the resistance is cut out of circuit, and the amount of current flowing may be made to vary in accordance with the rate-of-flow curve. We come to the last group of meters which directly weigh the water as it flows through the weir. It must be conceded that so far as power plant operation is concerned, this method has much to recommend it, seeing that it gives its information directly in pounds of water. It will be seen, however, that the task of weighing the flowing water is a difficult one, necessitating a more or less complicated form of apparatus. A typical example is the meter made by the Hoppes Manufacturing Company, of Springfield, Ohio (Fig. 11). This consists of a weighing vessel *W* of special shape suspended on a spring scale. It has flexible connections to the weir chamber *A* and to atmosphere *B*, and is so arranged that the scale is balanced at zero when no water is flowing through the notch. As the water rises in the weir, it also flows into the weighing vessel and, owing to the special shape of the latter, pulls down on the scale in exact proportion to the rate of flow.

The speaker then described in detail how the Lea V-notch meter developed by Mr. James E. Lea, of Manchester, England, was gradually perfected and adapted to the severe conditions of American boiler-room practice and the measurement of hot water. Space does not permit of our reproducing *in extenso* this section of the discourse, nor the many excellent slides with which it was illustrated. It may be of interest, however, to briefly describe a typical Lea meter as it is built in America to-day for the measurement of boiler feed water (Fig. 12).

The water to be measured enters the inlet compartment of the steel or cast-iron tank through a balanced control valve, passes under a baffle into the approach chamber, and thence through the V-notch weir into the large storage compartment below. A pipe connecting with the bottom or end of the storage chamber takes the water to the feed pump. This design of tank with storage chamber extending the full length under inlet and approach compartments is patented, and has several vital advantages. It provides an exceptionally large volume of water for pump storage, a long approach to the weir insuring accurate measurements, and moreover, by regulating the inlet by a float or bucket balanced upon this large pool, easily readable charts are secured. One corner of the inlet compartment is partitioned off to form a still-chamber for the float. This chamber is connected with the weir compartment by a small opening protected by a strainer. A very large and powerful seamless copper float rides upon the surface of the water in this still-chamber, and conveys its motions to the recording instrument mounted on the tank. In order to secure equal divisions on the chart, the recording pen is not directly attached to the end of the float rod, but a very ingenious compensating mechanism is interposed between these members, as follows:

A fine-toothed rack is formed upon the upper portion of the float rod and drives through a pinion a cylindrical drum supported on centers. Upon the surface of this drum is cut a screw thread of progressively increasing

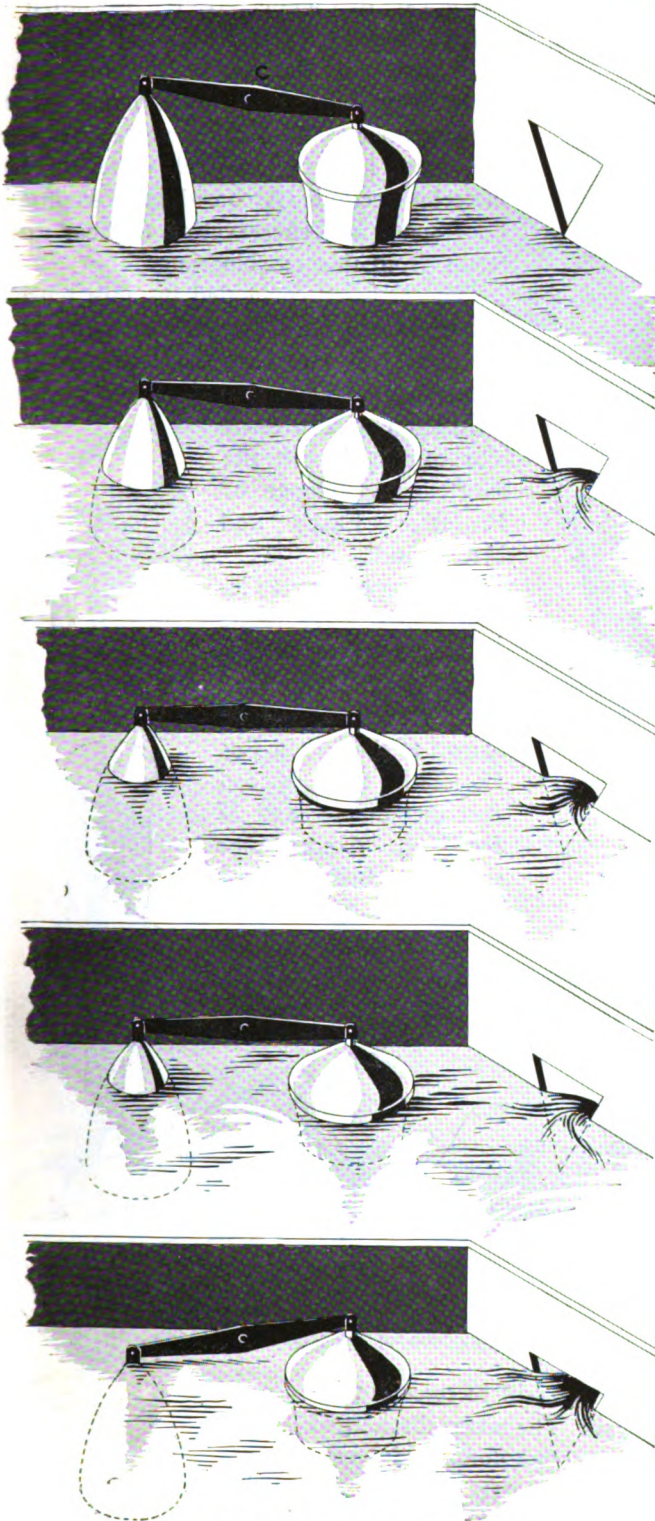


FIG. 9.—FLOATS OF THE BAILEY METER.

U-tube. The leg in which the lower level occurs carries a resistance element, such as a high resistance wire wound upon an insulator. This element is made part of an electric circuit in which is included a special differential millivoltmeter. As the mercury rises and falls in

pitch, corresponding to the $5/2$ power curve of the V-notch. This curve-of-flow is shown in detail in Fig. 13, and it will be seen that it is marked with graduations which form a convenient and sensitive indicator of the momentary rate-of-flow. A saddle arm travels in the groove and in turn moves a slider bar which carries the recording pen

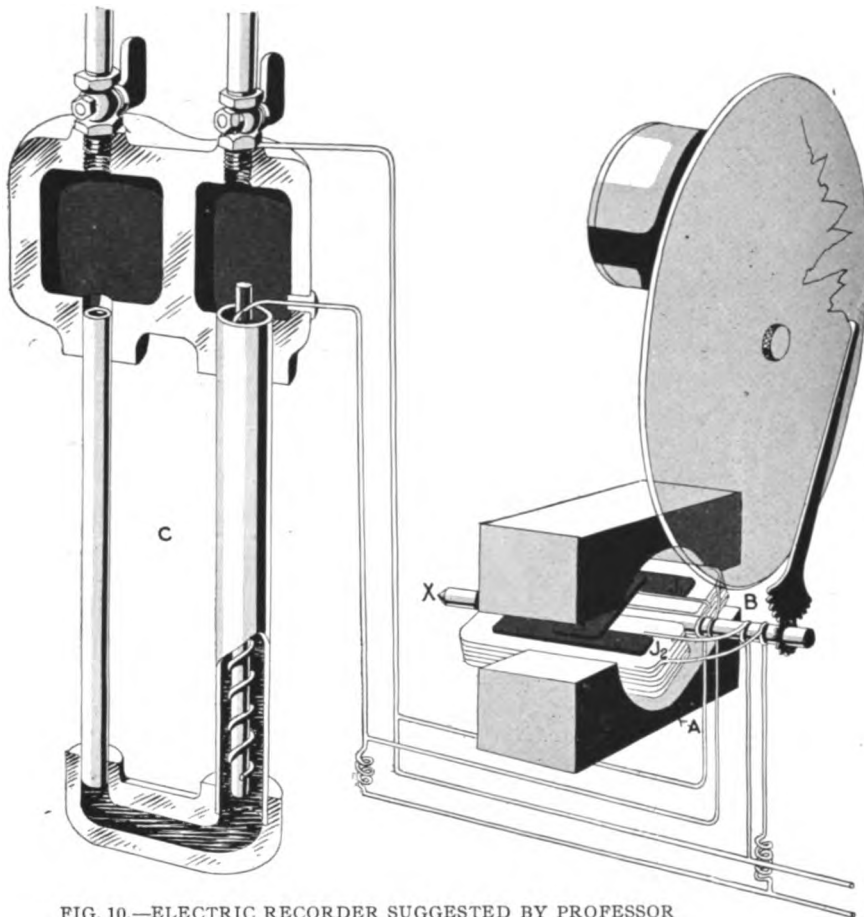


FIG. 10.—ELECTRIC RECORDER SUGGESTED BY PROFESSOR RATEAU.

in a lateral direction across the chart. The chart is driven by an independent clock giving one revolution to the drum in 24 hours. The charts not only have equal divisions, but are scaled in inches, so that they can be very easily planimeted. Where it is desired to avoid the necessity of averaging out the chart, the integrating device shown is added. It consists of an aluminum disk driven by a separate clock, and a train of counter wheels operated through a small friction wheel revolving on the surface of the disk. The speed of the counter depends upon the position of the friction wheel in relation to the periphery of the disk, and this is determined by the motions of the slider bar as the drum revolves.

As a check upon both the recording and integrating mechanisms, a scale is fitted in each instrument on which a pointer attached to the end of the float rod indicates the height in inches of water flowing through the notch at any time. By inserting this figure in the formula quoted above, the accuracy of the instrument may be readily checked at any time while in normal operation.

One American development of metering feed-water

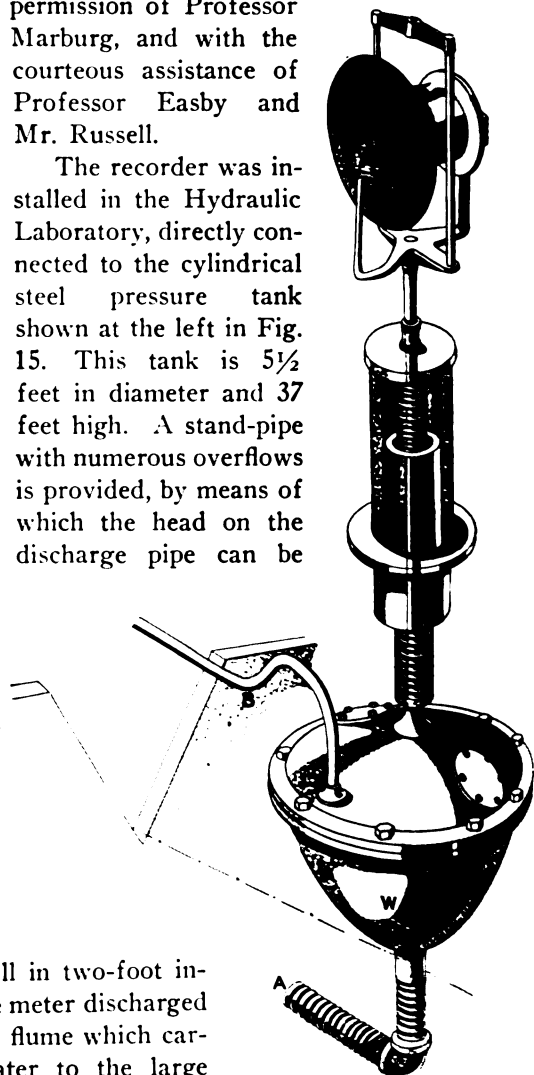
with the V-notch deserves brief mention; namely, that of a metering heater. The lecturer showed a number of very interesting slides of the Webster-Lea heater-meter, developed by the speaker's firm in close coöperation with Warren Webster & Co., of Camden, N. J. As shown in Fig. 14, a standard Webster open feed-water heater is

combined with the Lea meter, the water after being heated by the exhaust steam passing through an outside connection, and the usual balanced control valve, to the metering section. A considerable saving in floor space and conservation of heat units result from this combination.

The lecturer concluded his talk with a description of an elaborate test made of a standard Lea meter at the University of Pennsylvania, December 1, 1916, by kind permission of Professor Marburg, and with the courteous assistance of Professor Easby and Mr. Russell.

The recorder was installed in the Hydraulic Laboratory, directly connected to the cylindrical steel pressure tank shown at the left in Fig. 15. This tank is $5\frac{1}{2}$ feet in diameter and 37 feet high. A stand-pipe with numerous overflows is provided, by means of which the head on the discharge pipe can be

FIG. 11.—THE HOPPES RECORDING SCALE.



varied at will in two-foot intervals. The meter discharged into an open flume which carried the water to the large weighing tanks on the floor below. These tanks are of steel and have a capacity of about 15,000 pounds each. They are supported on accurate scales, sensitive to a weight of five pounds. A very efficient system of hydraulic valves allows of instant change-over from one tank to the other, and they can be emptied in 35 seconds. A hook gauge was attached to the weir chamber of the

RECENT DEVELOPMENT IN V-NOTCH MEASUREMENT

meter, and independent readings were taken of this every five minutes. The temperature was recorded on the same chart as the water by a recording thermometer fixed in the meter case and checked by a mercury thermometer

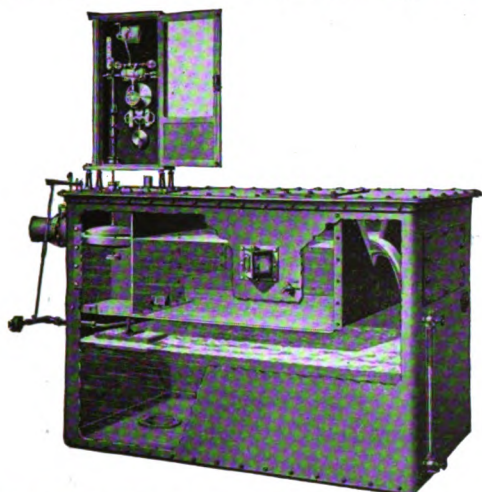


FIG. 12.—INDEPENDENT "LEA" METER WITH EXTRA STORAGE STYLE STEEL TANK.

at frequent intervals. All readings were double-checked. Fig. 16 shows the chart obtained and illustrates that a varying flow was maintained, from practically zero to a good overload, thus reproducing power plant conditions. The results were gratifying and are summarized below:

Total water weighed	154,559 pounds
Area of chart by planimeter..	4.23
Scale of chart	36,312
Total water by chart	153,599.76 pounds
Error of chart record against water weighed	-0.62 per cent.
Total water by integrator reading	156,500 pounds
Total error of integrator	+1.256 per cent.

DISCUSSION

Mr. J. W. Ledoux said it was not generally realized that the measurement of water flowing through a V-notch



FIG. 13.—PATENT CAM DRUM WITH RATE-OF-FLOW GRADUATIONS OF "LEA" METER.

is an exceedingly difficult problem, and, while there were doubtless quite a number of good practical meters on the market, none were yet perfect by any means, and there was room for improvement in all of them. One point, he stated, upon which he was left in considerable doubt was as to the difference between the Cochrane and the Lea meters. For himself, he could see no material difference, but probably the makers could. In his opinion, great credit was due to the makers of the Lea meters in this

country for their enterprise in developing the meter and gradually "ironing out" the mechanical defects which were to be found in the original instruments that were imported from England. The result was that, while in

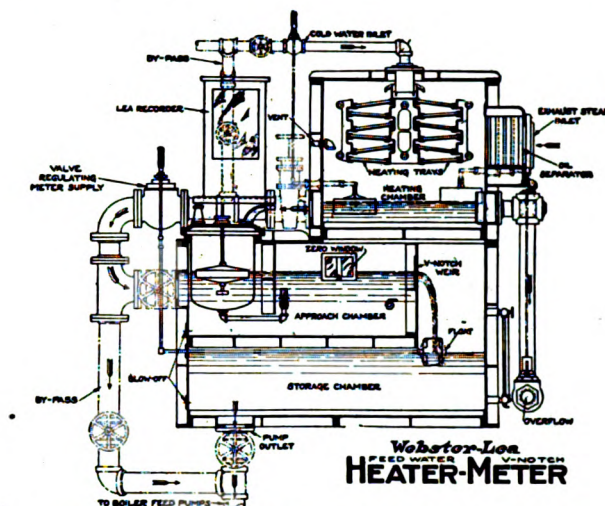


FIG. 14.—THE "WEBSTER-LEA" METERING HEATER.

theory the meter was by no means perfect, a very good, practical device, properly suited to actual boiler-room conditions, had been produced. To illustrate this feature, he pointed to the difference between the use of a cord for suspending the float and the use of the rack and pinion

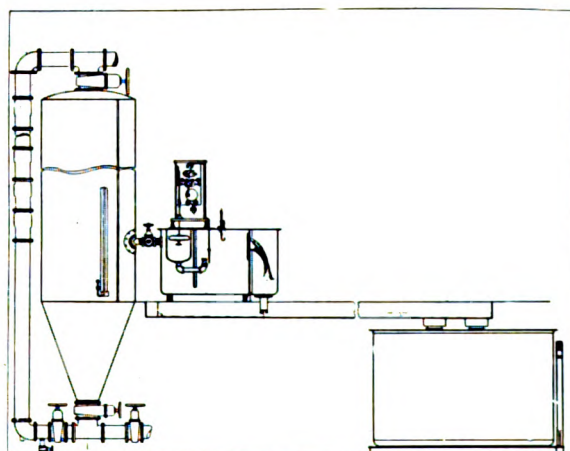


FIG. 15.—ARRANGEMENT OF APPARATUS FOR WEIGHING TEST OF "LEA" METER AT U. OF P.

in the Lea meter. Theoretically the rack and pinion must have lost motion and back lash, and cannot be as good a transmission as the cord, but it had been shown in

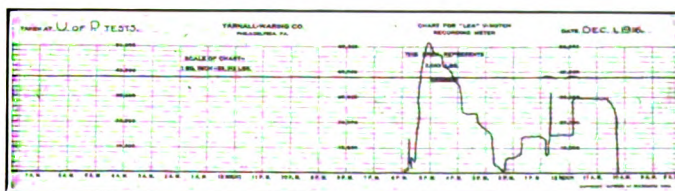


FIG. 16.—CHART OBTAINED FROM LEA METER TESTED AT U. OF P.

practice that when well made it is a more suitable means of transmission than the cord.

With regard to the University test described in the paper, Mr. Ledoux stated that he thought the accuracy figures would not have been as favorable if the meter had been running at a constant rate within one per cent. of the maximum flow.

He stated that of all the meters described, the Hoppes weighing scale was probably the most ingenious in theory, but there again in practice it was found to have defects, such as springs, flexible tubes, and other variables difficult of control.

With regard to the Bailey meter, the speaker stated that it was of excellent design, but he did not understand why the inventor had made both floats of curved contour. Two shaped floats were superfluous, and the original designer of this float system made but one float shaped and the other cylindrical, connecting the two by a cord running over a pulley. Here, again, he thought that the greatest defect was the complications introduced, which got away from the fundamental simplicity of the other meters.

He thought the Yorke weir was ingenious, but had proved itself impractical in actual use.

Mr. Charles H. Bigelow said that at his plant they used the V-notch meter for measuring feedwater, and steam-flow meters to keep track of the steam consumption, and found this to be an excellent system for maintaining maximum efficiency in the plant. He considered V-notch water meters highly satisfactory measuring devices.

Mr. Thomas C. McBride reminded the meeting that a demand for some sort of a metering device for hot water for boiler feed had existed for many years, but that no apparatus had been developed until quite recently that could be depended upon to maintain its accuracy under continuous operation. He thought that great credit was due the various firms which had developed the apparatus described in the paper, whose efforts to meet these demands had resulted in there being placed on the market a number of entirely satisfactory boiler-feed meters.

Mr. Moody called attention to the fact that the flow through a V-notch does not exactly obey the five-halves-power law, and asked whether any of the forms of V-notch meter now being built make any attempt to correct for the slight variation of coefficient which should be used in the formula. Mr. Moody suggested that it would be desirable if the cam curves used in the recording devices could be corrected to give the exact discharge.

After Mr. Yarnall had answered questions raised by various speakers, and Mr. Ledoux had furnished some additional information, Mr. Emmett B. Carter, in closing the meeting, mentioned that at the plant of the Midvale Steel Company they had first experimented with Venturi meters for boiler feed, but they had found in their particular case the records needed considerable watching if any reliance were to be placed on them. They then changed over to V-notch meters, which are giving entire satisfaction.

The meeting concluded with a hearty vote of thanks to the speakers, which was carried with acclamation.

(Continued from Page 313)

THE ORDNANCE OFFICERS' RESERVE CORPS

Captain J. B. McCord, of the Ordnance Department, states that they are receiving applications for very high-class mechanical, chemical, and electrical engineers, scientists, executives, etc., and, for the benefit of those members of the Club who might wish to apply for commissions in this department, he has sent a number of copies of general information concerning this corps.

1. The Chief of Ordnance of the Army is charged with the duty of procuring by purchase or manufacture and distribution the necessary ordnance and ordnance stores for the Army and the National Guard. (Par. 1511, A. R. 1913.) Ordnance and ordnance stores include cannon and artillery, vehicles, and equipments; apparatus and machines for the service and maneuver of artillery; small arms, ammunition, and accoutrements; horse equipments and harness for the Field Artillery, and horse equipments for Cavalry and for all mounted men; tools, machinery, and materials for the ordnance service; and all property of whatever nature, including specially equipped motor trucks, motor cycles, tractors, and railroad cars, supplied to the Military Establishment by the Ordnance Department. (Par. 1512, A. R. 1913.)

2. The personnel of the Ordnance Department comprises commissioned officers, enlisted men and civilian employees. The commissioned personnel includes the officers of the Ordnance Department, United States Army; Ordnance Department, United

States Reserves, and Ordnance Officers' Reserve Corps. The first class comprises Regular Army officers who make the study and practice of ordnance engineering their life profession; the second class comprises officers called into active service with the Ordnance Department by selection from the inactive list of the Ordnance Officers' Reserve Corps; and the last class comprises executives, scientists, engineers (mechanical, electrical, chemical, etc.), chemists, metallurgists, etc., ordinarily engaged in civil pursuits, who engage to give their services when needed by the Government.

3. The Officers' Reserve Corps is authorized by sections 37-40, 49, and 51-53 of the national defense act, approved June 3, 1916, and includes, among other sections, the Ordnance Officers' Reserve Corps. The regulations prescribed by the President to carry the same into effect are published in Regulations No. 43, War Department, 1917, which also quote in full the above-mentioned sections of the national defense act.

Officers of the Ordnance Officers' Reserve Corps will have the grades of first lieutenant, captain, and major. The pay of these grades is as follows:

	Per annum.
First lieutenant.....	\$2,000
Captain	2,400
Major	3,000

Copies of this circular of six pages will be sent to any member who may request same from the Secretary.

NINTH NATIONAL CONFERENCE ON CITY PLANNING KANSAS CITY, MISSOURI

By B. A. HALDEMAN

ASSISTANT ENGINEER, BUREAU OF SURVEYS

THE Ninth Annual Meeting of the National Conference on City Planning held in Kansas City, Mo., May 7, 8, and 9, 1917, was one of the most successful, as well as one of the most important and interesting, yet held by that organization.

When the decision to hold the Conference in the Middle West was reached by the Executive Committee there were some misgivings as to its ultimate success, as it was thought the holding of the Conference so far from the large eastern cities might result in failure to obtain the attendance necessary to insure its success. These misgivings were dispelled, however, before the first session was called to order, and the Conference proved to be one of the most representative yet held, bringing together as it did the men in active control of city planning and city development from every part of the country. Twenty-five states and seventy-five cities were represented by 250 delegates. Philadelphia was represented by five delegates. The Conference was held under the auspices of the Chamber of Commerce of Kansas City, assisted by the real estate organizations of that city, and its success was very largely due to the great interest taken by the men actively engaged in land development in the rapidly growing cities of the Middle West.

Some of the ablest and most influential men engaged in promoting better city development in the eastern cities met those from the cities of the Middle West and the Pacific slope engaged in similar activities, and the work of the Conference disclosed that the enthusiasm of the West in matters relating to city planning equalled, if it did not exceed, that of the East, and that the West was making great progress toward the actual accomplishment of its ambitions. The West seems to have some advantage over the East by reason of a more general and hearty coöperation among the various interests involved; the real estate interests in particular are much more sympathetic and helpful than in the East; in fact, the latter interests are in some instances the strongest supporters of the general city planning movement. Western legislatures and courts also seem to take a broader and more liberal view of what is necessary and proper for the development and protection of the common interests of the people. This attitude of coöperation all along the line is certain to produce early and important results, and the energy, enthusiasm, and accomplishment of the West will set a new standard for the East.

Some of the more important subjects discussed before the Conference were: "Interurban Passenger Terminals and Industrial Terminals"; "Trafficways and Parkways"; "Street Widening and Improvement to Meet

the Needs of Traffic"; "The Development of Park and Parkway Systems"; "The Development and Improvement of Inland Waterways"; "Better Planning for Small Cities"; "Campaigning for Better City Planning by Real Estate Interests and Methods Advocated and Employed by Real Estate Interests of the Middle West in the Promotion of Better City Development"; "The Relation of City Planning to Business"; "The 'Zoning' or Districting of Cities for the Protection and Promotion of Health, Safety, Order, and the General Welfare, and the Legal Status of 'Zoning' or Districting." Many problems of lesser importance were also discussed, such as "Street Signs and Street Encroachments," "Street Widths and Street Improvements," "Community and Neighborhood Centres," and "The Smoke Nuisance."

INTERURBAN PASSENGER TERMINALS

Interurban passenger terminals came before the Conference as a subject of large importance for the first time. The development of such terminals has been the outgrowth of the demand for better transportation facilities, not only within the city but also between the city and suburban points and between cities a considerable distance apart. The problem of the location and development of these terminals is one of importance to every city, but particularly to those of the Middle West and West, where cities have not generally grown to the size of those of the Atlantic seaboard, but where the necessity for interurban transportation and the linking together of neighboring communities through the medium of high-speed transportation has become a controlling function of growth. These cities still have the opportunity to prevent the evils which have grown up in the larger cities through their early neglect of transportation needs. Radiating from many of the cities of the Middle West are great systems of suburban electric railway lines reaching, in some cases, all sections of a state. This situation is perhaps best illustrated by the city of Indianapolis, from which twelve suburban electric railways radiate, connecting the capital with all parts of the state. These lines enter a union terminal in the centre of the city near the Capitol, and one of the important questions raised before the conference was whether this was the most practical and serviceable method of handling the interurban business, or whether it should be distributed through several terminals located on the outer edge of the city. The general opinion seemed to be that, except in certain instances where traffic conditions were unusual, the interurban business should be handled through terminals located outside the main city centre, connected by belt lines and by lines

through-routed across the city from terminal to terminal. The objections of passengers to changing cars was offered as an obstacle to this form of development, but the contention was held that if the routing is done in such a way that passengers gain something in general convenience and in time saved by making a transfer the objection to such changes would be overcome.

The recently constructed Newark three-level terminal, where transfer of passengers from New York is made to the lines of the Public Service Company which radiate from Newark through all parts of northern New Jersey, was used as an illustration of an interurban terminal which might serve the people best by being located in the city's centre, but it was felt that the general public would ordinarily be better served by the establishment of such terminals farther out from the centre. One advantage claimed by the advocates of terminals on the edge of the city was that they would encourage the breaking up of the tendency toward congestion and concentration in the city's centre and the extension of business and trade to the outer edges of the city, and would also aid in the development of satellite cities adjacent to the larger municipal centre and the general spreading of population.

INDUSTRIAL TERMINALS

The establishment of industrial terminals similar to the Bush Terminal in Brooklyn was advocated, the advantages claimed for such a terminal being: The organization of general industry in locations easily and economically served by water and rail transportation; the economy of space, of power, light, and elevator service, and generally of all service necessary to successful and profitable industrialism; better sanitary conditions; the improvement of industrial architecture; better freight receiving and distributing facilities; economy of land values and rentals and lower taxes; and reduction of fire hazard and fire loss, with consequent lessening of insurance rates. All these are elements of large importance in the economy, efficiency, and productiveness of industrialism.

TRAFFIC WAYS, PARKWAYS, AND STREET WIDENING

The development of the city's street system to meet the needs of transportation and circulation has always been one of the most important subjects before the conference. Although it has been discussed at every meeting, there is always some new thought to develop. It has come to be very generally agreed by the conference that there should be a marked differentiation in the location and widths of primary and secondary streets laid out for general traffic uses and in minor ones for purely residential purposes; also that there should be a differentiation amounting to dual systems for general traffic and for parkway purposes. Differentiation for these latter purposes seems to be desirable in view of the very rapid development of the motor vehicle for both business and pleasure uses. It seems wasteful in time, money, and

service to attempt to handle great numbers of heavy motor trucks engaged in the transportation of freight upon the same highways used by lighter vehicles of high speed bent upon lighter service or upon pleasure.

The problem of obtaining greater facilities for transportation in congested city centres is one that is receiving much attention, and the solution of it will involve large expenditures of public funds, as the only practical means of providing additional traffic areas in city centres seems to be to adopt one of the following methods suggested in the Conference, all of which are now employed to some extent:

First.—By setting back the curbs and increasing the roadway width. This method does not seem to offer very satisfactory results, as sidewalk widths at present are not generally more than sufficient to accommodate pedestrian traffic upon streets where widening is necessary. It is however, a simple method which might be employed where sidewalk traffic can be sacrificed for roadway traffic.

Second.—The actual street widening by cutting off portions of lots and buildings on one or both sides. This method would obtain the desired results, but involves large expense.

Third.—A progressive widening by the establishment of new street lines, with the requirement that all new buildings erected or old ones altered be set back to the new lines. This is an economic method, but involves an extremely slow process.

Fourth.—The widening of the roadway by appropriating practically all the sidewalk space and placing the sidewalks in arcades back of the building lines. This appears a practical, though expensive, method. It would result in increased roadway and sidewalk facilities, but would not increase light or air space of the street.

CAMPAIGNING FOR BETTER CITY PLANNING BY REAL ESTATE INTEREST

One of the most interesting sessions to the Easterner, perhaps, was the one devoted to the discussion of the ways and means by which real estate men can assist a city toward better development of all its activities. The real estate men of the Middle West assume an entirely different attitude toward city planning from that of men engaged in the same line of business in the East. Where the Western real estate man feels that city planning is going to benefit him and the development of his property, and is largely in his interest as well as in the interest of the general public, the Eastern real estate man seems to feel that progressive, broad-gauge measures of city planning are an attack and an encroachment upon him and the rights of property. Some of the ablest and best known real estate men of the Middle West made strong pleas for coöperation between the municipal authorities and the real estate men in promoting more progressive, economic, and thorough methods of city planning. While it is the general practice in the Eastern cities for the real estate owners to obtain the largest possible amount of damages for the opening of streets for the development

of property, the real estate owners of the West not only dedicate the streets necessary for the development of their property in accordance with the wishes of the municipal authorities, but also grade them and put their land in condition for immediate building improvements at their own expense. What the Real Estate Association of Indiana did might be emulated in our Eastern states. The Real Estate Association of Indiana organized a party of aggressive real estate men and men foremost in city planning activities and made a tour of the state lasting several days and visiting most of the important cities. A preliminary schedule and program of the tour was sent out in advance, and the travelers were met at every stopping place by enthusiastic audiences composed of the city officials, citizens, and real estate men interested in the development of the various cities. A campaign such as this conducted in every state of the Union could not fail to bring the municipal authorities, the real estate men, and the citizens into closer coöperation and give them a broader view of the benefits the community could derive from such coöperation. In the West it is a matter of community benefit; in the East it is a matter of contention; the Western principle will ultimately prevail, but it means a hard fight in the East.

"ZONING" OR DISTRICTING

There is no problem of city planning before the country to-day that is of more vital importance than that of "zoning" or districting. It is generally agreed that the time has come when there must be a more orderly development of our cities and a better distribution of their various activities. The segregation of commercial, industrial, and residential districts seems to be essential if the city is to develop in an efficient and economic manner with a view of preserving and protecting all the community interests and rights which go to make for healthy city growth and normal city prosperity. The agitation of this problem is of comparatively recent growth, but it has made more progress toward real accomplishment than any other of the big problems of city development. "Zoning" or districting, in its broadest sense, depends upon the wise and reasonable exercise of the police

power, since it would not be possible for the city to assume the expense necessary to produce the results desired through the exercise of the power of eminent domain. This latter power has been, and is still being, used to a considerable extent in promoting better city growth and in protecting the public interest, but, as the exercise of his right invariably results in large cost to the city, it is not practical to employ it as a general policy in controlling the character of improvements placed upon private property. The character of such improvements can be controlled in the interest of the public through the exercise of the police power where such control can be shown to be necessary to the public welfare. Many states have passed acts authorizing the "zoning" or districting of cities, and many cities are engaged in formulating ordinances controlling private improvements. The right of the municipal authorities to place reasonable regulations upon the use of private property through the police power and for the purpose of protecting the health, safety, order, and public welfare has been recognized and upheld by the municipal and state courts and by the Supreme Court of the United States. Here again the aggressiveness of the West is evident, a case having gone from California to the Supreme Court of the United States involving the right of the city to establish residential districts and to not only forbid the erection of new industries in such districts but to order those already existing to remove from them. The right to do this was upheld by the court and appears to firmly establish the right of a city to regulate the use of property, providing such regulation is reasonable.

The right of a city to regulate the height of buildings and to establish different heights in different districts has been upheld by the same court in an opinion handed down prior to the California case.

At the business session which closed the Conference a change in organization was effected. The name was changed to The American City Planning Institute and a charter was adopted providing for several classes of membership, for dues of the various classes, for methods of governing the Institute, and for technical meetings of the Institute, as well as the popular annual meeting.



MILITARY AERONAUTICS*

By MAJOR WILLIAM MITCHELL

CHIEF OF STAFF, AVIATION CORPS, U. S. A.

I WISH to make this an informal talk and not a lecture in any way. My object this evening will be to convey to you some idea of what we are doing or trying to do with aviation in this country, for, as you all know, the first practical heavier-than-air flying-machine was demonstrated in this country, but until the present year very little attention had been paid to its development in this country. We are now going forward in the attempt to gain our appointed place in the development of this important military adjunct.

The conception of the air in its relation to aviation possibly needs some explanation to those persons who have not given special study to this subject. We heretofore have considered the air as a medium into which we could not go, or at least a place where it was very difficult to go; but I think that the future will show that the air, as a place for transportation, offers less resistance to the passage of bodies than does the surface of the ground. There are no bridges, no tunnels, no cuts, and no fills. It has its storms, to be sure, but it is very much easier to go through air than through water or over the surface of the earth.

I will try to explain to you what our organization is at present in this country, and some of the points about aeronautics in other countries, and I hope that you will ask questions whenever you desire to do so.

Appropriations were made by Congress for the construction of a flying-machine by Doctor Langley which proved to have every element about it that is necessary for a successful aeroplane. Some accidents were encountered in its actual development, and in those days the builder of a flying-machine was looked upon as a crank. Only a few years ago Doctor Langley's flying-machine was taken to a lake in New York, where a modern engine was installed, and actually flown with a man in it, showing that twenty years ago—for this machine was so constructed by Doctor Langley in 1896—in this country we had a flying-machine capable of flight, and it has been developed only a little further since that date.

These flying-machines of Langley's were readily developed from gliders that had been made at various times, and in which a good many of the principles of heavier-than-air flight had been worked out; all that was needed was a motor to give these machines the necessary propulsion through the air so that they could fly.

The Wright flying-machine that was tried out at Fort Myer, Va., was really the first machine in the world's

history to fly in a proper manner and under perfect control of the pilot. And it is quite interesting to note that Colonel Squier, who is the head of the Aviation Section in this country, was the first passenger carried by this flying-machine or any heavier-than-air flying-machine in public. He was also the first man to draw the specification for a heavier-than-air flying-machine.

One of the salient features that the Wright Brothers brought into their flying-machine was the warping of the ends of the wings. When we make a turn with a heavier-than-air flying-machine it must be inclined so as to bank against the air, or it will slip sidewise. By warping the ends of the wings the flying-machine can be inclined so that it banks against the air, which prevents it from going sidewise. That principle is really what the Wright patents all depend upon. It is claimed that the Wrights control all flying-machines that have the ends of the wings changed in any manner for the purpose of turning and manœuvring. This principle is applied in all successful flying-machines nowadays. The flying-machine had only about a 20-horsepower motor, and it was marvellous the way the Wrights could fly it. They had no reverse power whatever when they got into "rough" air, and the machine had to be flown much as one would ride a high-wheeled bicycle. They were really marvellous flyers.

Since the Wright flying-machine, which was a biplane, a great development has taken place, particularly in Europe. Congress in this country and the people failed to appreciate the necessity for action and to appropriate the necessary money. Rapid development took place, particularly in France, in which country it was developed along what we might term sporting lines, as distinguished from military lines. In this connection we may say that aircraft are used for two principal purposes in warfare. One of their uses is at a distance from the field of battle, and the other is right on the field of battle. Each type of work, such as reconnaissance work or photographic work or other work, requires certain special types of aeroplanes. Some nations took that in hand and developed types absolutely in accordance with the work they knew they had to perform in war. In other cases the aeroplanes were developed only for sporting purposes. In sport, speed is the great element. The French developed along the lines of speed—great speed—which is notable in the monoplane. The monoplane is weak structurally, however, because it is a single plane. Other nations kept the biplane. In this country we always kept the biplane.

Aeroplanes are used not only on land but on water.

*Presented at Regular Meeting of the Engineers' Club, November 21, 1916.

The latter types of machines are fitted with pontoons. In some cases there are single pontoons with small floats on the ends of the wings to keep them up. Others have two pontoons, and then there are still other types which have boat-shaped floats attached.

There is another American invention—the flying-boat—which is used a great deal for sport nowadays, and is a very convenient machine to ride around in. It provides a very comfortable place to sit in, but, on account of the heavy resistance it offers to flight straight ahead, it has only its special uses. Some of the men in Philadelphia have these flying-boats on the Delaware River in which they are doing good flying. All these water machines are capable of being operated from comparatively still water, but in the sea and where the waters are high it is very difficult for them to land, and equally difficult for them to rise. In the army we use these flying-boats with supports on them so that we can land in the water in connection with coast defense and for the observation of coast artillery fire.

The matter that I wish to bring out particularly this evening is the organization which we have adopted in this country for the development of air service. The air service is, as you know, only one small part of the army; it is gaining in importance all the time, but it has to be coördinated with the rest of the service, so that the air service itself which any army has is dependent on the general military organization of the country.

In this country our land forces are organized into what we call a regular army, which is constantly under arms, under the National Government, and a National Guard, which consists of citizens, under certain conditions, and is under the National Government. The regular army is organized into what we call tactical divisions that are mobilized, and coast-defense troops; that is, the coast artillery, which has guns protecting the water areas around the great ports and harbors. The National Guard is maintained by the states and is also organized into divisions. These divisions are little armies in themselves. They have their infantry, engineer, artillery, cavalry, and special troops. They are able to operate independently and fight independently. Each one of these organizations has an air unit with it so as to make it complete, and that is the basis of air organization. We call these units air squadrons. The air squadrons have a total of twelve aeroplanes on line; twelve aeroplanes in the depot that goes with it, twelve machines in reserve—a total of thirty-six machines fully equipped. To man these twelve machines requires twenty officer flyers and 150 men. A complete equipment of motor trucks, portable machine shops and equipment of that kind is needed in the field.

The country is organized into different districts, corresponding to the divisions of the National Guard. In addition to these twelve National Guard divisions there will ultimately be seven divisions of the regular army. The first problem for the air service is to organize nineteen air squadrons to correspond with these organizations of the army. In addition to organizing the air units to work

with the coast defenses in and around the great harbors and waterways. Not only do the cities need to be protected in connection with the coast defenses, such as Philadelphia, New York, and so on, but provision also needs to be made to keep hostile aircraft from coming over and dropping projectiles of various sorts on the cities. That is provided for not only by anti-aircraft guns, which protect the immediate locality, but principally by fighting machines that get right up in the air and fight the hostile machines. The plan has been worked out that wherever harbor defenses are located they will be provided with aircraft to spot their fire and that sort of thing, and the plan also provides them with fighting squadrons whenever necessary. That is contemplated for Philadelphia, and squadrons will be organized for service and stationed below the city as soon as we are able to train the personnel. You can readily see what this whole proposition involves in organization, as we had to start out this year with practically nothing in this country. The total amount of money that had been appropriated up to 1916 was \$900,000 for the army; the navy had a little bit more than that. But when you think that the equipment of one air squadron involves an expenditure of \$800,000 and that in eight years only \$900,000 has been spent, you can see how little could be done to develop this science and art.

As I say, the army found itself confronted with not only a lack of personnel for flying, but a total lack of mechanical personnel. The only thing we had to fall back upon was that a few officers in the regular army had been trained in modern methods of aviation.

In the development of this service, then, we had to take into consideration three principal things: the executive organization, whereby the command and direction are in one person and in one place; the training of the personnel by whatever means that could be found, and the obtaining of adequate material to furnish the trained men.

As I said before, the kind of material used should depend on the uses to which it is to be put, but the first thing we had to do in this country was to take what material we could get and put it into the hands of the people we are training. In the development of this personnel we have gone not only to the army but also into civil life, and we have gotten the best qualified persons we know of in this country in all lines to help us, particularly in engineering lines, in motor lines, in the development of special accessories. We have gone wherever the most highly talented engineers could be found, and they have all come forward in a most willing manner. We seek advice from the industries themselves; for instance, in motors we have meetings of the prominent motor engineers and designers of the country; they have regular proceedings, and any questions which they desire to take up and develop are immediately looked into, and that information is disseminated to the makers of motors. About the same thing is done with manufacturers of aeroplanes; and the same thing is done about various accessories. Every endeavor is being made to develop material along the broadest lines possible.

As to the training of the personnel, this branch of the army has utilized and will utilize the advantages which are offered by the various civilian schools and manufacturers' schools in the country. There are really very few of the schools competent to give instruction, but each one that is will be certified to be proficient by the government and selected men from civil life will be sent to them. Their instruction in these schools will be paid, and their training will be finished in government schools, when they will be commissioned as reserve officers and some of them will be placed on active duty with squadrons throughout the country. These squadrons will be either organized from the reserve corps personnel or from the personnel from the regular army.

We will discuss units such as we wish to put near Philadelphia. These units will be composed of reserve officers with a permanent engineering staff constantly on duty with the unit and a permanent executive staff. That will amount to about three officers being on duty with that unit all the time, and about twenty men. The rest of the flyers may follow their civil vocations, will be right here in the city, and can report at stated times, to practise with the aeroplanes. During possibly two weeks of the year the whole unit will be mobilized and will have practise as a squadron. This is the first time, really, in the history of the country that this system has been actually tried practically by the Federal Government, of taking citizen reserve units and actually putting them on duty in the federal service in time of peace. You see this scheme actually gives us three lines, the regular army, the reserve, and the National Guard.

We are also encouraging all the universities we can to establish courses in aero-dynamics and to develop engineers. There is a great dearth of aeroplane engineers in this country. We cannot get them from Europe because they want to keep the competent men.

There are several aviation schools maintained by the United States. The \$13,000,000 appropriated this year became available only on the twenty-ninth day of August, 1916, so that we have only September, October, and part of November to carry these things out. We had the project worked out ahead of that time, but, as you know, government funds cannot be actually spent until the money becomes available. There are three rather large government schools already established; one at San Diego, Cal., which is on the Pacific Coast; one at Chicago, and the third at Mineola. We are establishing two more schools—they are being established by manufacturers; one at Newport News and one at Miami, Fla. There will be one or two schools established here as soon as the personnel and material can be assembled. In addition, we shall maintain instruction whenever it is necessary for the reserve corps. Hangars are constructed to protect the aeroplanes when not in use. Each hangar contains its aeroplane and spare parts for it, each machine has its mechanics and its crew assigned to it, and each instructor has his aeroplane with about five pupils assigned to him. There is a man who notes every time a machine leaves the ground, and

when it comes back, what the condition of the air is, and anything worthy of note, so as to give a record for all flights, and the weather conditions throughout the year. The pupil receiving the instruction is carried through progressively from one thing to another. There are two general systems of instruction. One is known as the "penguin" system, which is used in Europe a great deal—principally in France. The "penguin" is a machine that cannot fly. Its wings are purposely made small and cannot support it. The student is put in and allowed to experiment with the thing, until he learns how to manipulate it on the ground. After this has been accomplished he is permitted to use a machine with a bigger wing area until he learns to fly practically by himself. That system of instruction was carried out in this country six years ago. The other scheme is to have the instructor in the machine with the student, who is immediately taken into the air and gradually given the control until he can take care of the airplane himself. This system is usually followed wherever sufficient instructors can be obtained. We have regular Civil Service instructors. Our instructors get \$300 a month. The seniors get \$350 and the chief instructors get \$400. They receive \$200 more for every year's service until a maximum of \$6000 a year is obtained. Not every expert flyer, however, makes an instructor. We are developing instructors from excellent flyers. When the time comes for cross-country flying instruction, the flying formation and the maneuvers required are directed by the military personnel. The ordinary schools such as we have in this country are conducted along these lines.

In addition to teaching our pupils how to fly, we also teach them as much as we can about motors and elementary aero-dynamics; also something about the weather, so that they can tell by looking at the clouds what to expect when they get up in the air. We teach them map reading, photography, and similar subjects, giving them as much instruction as is possible in the time.

We use two grades of aeroplanes in training the primary and advanced. The primary has a very low landing speed, and the slower an aeroplane goes the easier it is for a person to land in it, and pupils, as they are taught, have to be graduated from one aeroplane to another until they can get up to the powerful, big aeroplane and the very speedy fighting aeroplanes.

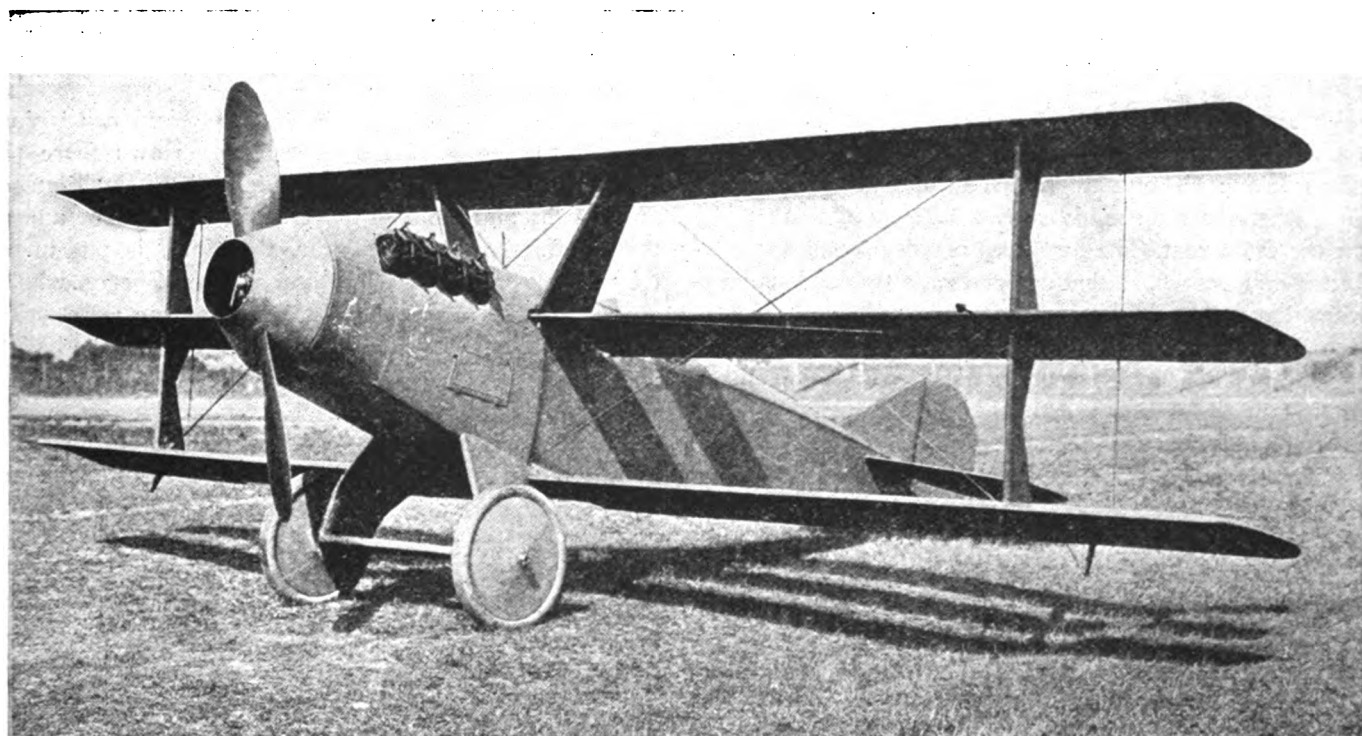
It is interesting to note, for instance, that about 500 engineering drawings have been completed for some types of aeroplanes, and yet they are not developed fully, but some are as near a "Ford" of airplanes as exist in this country. Such aeroplanes are ordinary, everyday things, and can be turned out in big lots. Of course, the same applies, to a certain extent, in other countries, but they have gotten certain types that are largely standardized and are very much ahead of us.

Some aeroplanes have a speed in the air of about 90 miles an hour and a landing speed of 50 miles an hour. The aeroplanes are equipped with all the ordinary instruments. The tachometer shows the revolutions of the

propeller, which is the most important instrument in an aeroplane, because it indicates more quickly than anything else any trouble with the motor. There are also an aneroid and a clock. I might speak of some accessories that are used in an aeroplane—a great many of them, by the way, are made in Philadelphia. For instance, we have a ground speed indicator that is made here. By looking through this instrument at the ground and noting the time it takes by a stop-watch for an object to pass between two cross hairs in this instrument one can tell the speed at which he is moving over the ground. There is also another instrument which indicates the speed through the air, and it will indicate to the pilot whether he is coming dangerously near

with the average machine gun. In some aeroplanes the gun fires through the propeller shaft, in which case the aeroplane has to be pointed when the machine gun is fired. In other cases the gun is keyed on to the propeller shaft so that its discharge will not upset the propeller.

The necessity for the various types of aeroplanes I will touch on later. Before we had aeroplanes we sent troops out to fight for what information they could get, and the strategical patrol for cavalry was one, two, or three men that went out and attempted to get information by scouting, but did not engage in fighting. In Europe when they intend to go on a bomb-dropping expedition for the purposes of destroying some particular place,



THE NEW CURTIS TRIPLANE SPEED SCOUT

Which can climb 1000 feet per minute, and has a speed range of 45 to 115 miles per hour.

the stalling-point, because when his machine is stalled it has to fall a sufficient distance to gain speed to glide. This is particularly important in flying, because it is difficult to tell sometimes how fast one is going.

There are also some instruments for showing the angle at which the machine is inclined, and an instrument called an "automatic pilot," operated by a gyroscope, which can be used to control and fly the aeroplane.

Of course, the compass is always used in determining direction, and that is particularly necessary, because one is in the clouds a good deal of the time and in a hazy atmosphere, and a good many of these compasses have an arrangement on them so that if flying in a wind that comes from one side the operator can tell the drift of it and make up for that.

As most aeroplanes work more conveniently with the propeller ahead than with the propeller behind, a great deal of difficulty is found in firing through the propeller

with the average machine gun. In some aeroplanes the gun fires through the propeller shaft, in which case the aeroplane has to be pointed when the machine gun is fired. In other cases the gun is keyed on to the propeller shaft so that its discharge will not upset the propeller.

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forty or fifty bomb-droppers, each carrying eight or ten bombs, are grouped. They proceed at the comparatively slow speed of about seventy-five to eighty miles an hour, and in order to get over the hostile lines it is necessary to get up very high in the air. The aeroplanes start at twenty seconds intervals and the leader is marked zebra fashion. They go off to the rendezvous, usually ahead of time, and keep circling up until they reach their proper altitude, and after they have been gone a sufficient time the fighting aeroplanes take the air. The proportion of fighting aeroplanes is about one to each bomb-dropper. When the aeroplanes reach their proper altitude they get into a V-formation, similar to a wild-goose formation: the leader takes the lead and signals that they are ready to go. The V-formation is necessary because it has been found that in the wake of every machine there is always bad air. If one follows a machine too closely he can feel it retard. The fighting aeroplanes form an oval above and below

the bomb-droppers, because with this formation they are able to ward off attacks from above or below. The minute they are discovered, the aeroplanes on the other side come up to attack and a series of combats take place in the air, and the bombers go ahead with their project.

The leaders are able to signal by shooting with a pistol, a cartridge which has a smoke tail to it. At night various colored lights are used. Before dropping the bombs the leader signals when they are to get into column or one behind the other, and he also signals whether the bombs are to be dropped successively or all at once. When they get through they attempt to get back into this V-formation, but sometimes they have to scatter and get back different ways. The reconnaissance and photographing aeroplanes are convoyed. It is quite interesting to note that for photographing one has to get up around 16,000 feet to keep away from the anti-aircraft guns, particularly on clear days. They use for this work cameras about 42 inches total length. We are just developing this type of aeroplane. The photographer usually gets in the back seat, where he can use his camera, and the pilot is usually on the front seat. The negatives are developed and projected on a screen, so that one can get a tremendous magnification from the photograph taken.

The portable machine shops are all equipped on trucks; have lathes, boring machinery, a blacksmith forge, and so on, so that hasty repairs can be made in the field.

Air squadrons in the future will be equipped with tent hangars for each machine. The steel hangars will be at the advanced depot. We are trying to develop a machine that can stay out in the open without any hangars at all.

It is interesting to note that we are depending on Ireland for practically all the aeroplane cloth we can get. So far the best material found for this purpose is Irish linen. We are trying to develop airplane cloth in this country, and the Bureau of Standards is working on the subject. We may be able to develop a long staple cotton for this purpose. I merely mention this to show you that there is nothing that we have not taken hold of and developed the best, or which we think is the best, for the purpose.

When we first went down into the high, dry altitude of the Mexican border the temperature went through a great variation between day and night, and we had considerable trouble with our propellers. They buckled and warped and came apart in the air, which is a very serious thing, because when a propeller comes apart in the air it nearly always smashes the front of the aeroplane to pieces and is very apt to kill the pilot. We tried every kind of wood we could get—walnut, spruce, mahogany, and several others; we tried burying the propellers under sand; we sent the best propeller wood we could get down in Columbus and established a propeller factory. Upon investigation we found that the Italians had the same sort of difficulty in Tripoli and had overcome it, as the British did in India. We solved the problem and are having no more trouble. The thrust of these large motors is tremendous—200 horsepower. The speed at the end

of the blades is seven miles a minute, and the least abrasion throws the propeller out of balance so that there is a liability of its being wrecked. We have attempted the use of metal propellers and have different experts working who are making satisfactory progress.

We have tried all sorts of propeller designs—two-blade propellers, three-blade propellers, and four-blade propellers. We have tried them tipped and not tipped. The British use the four-blade propellers a good deal, but we have not had good success with them. One disadvantage we have found in the use of the four-blade propeller is that it is a great deal more difficult to cool the engine than with the two-blade propeller. The reason for that is that with the four blades there is twice as much surface in front of the radiator. One might think that it would hardly make any difference, but it does make considerable difference.

In this country, and in Mexico in particular, it is very difficult to find good landing places. Down there the country is covered with a certain growth of small bushes and shrubs and landings have to be made right among that stuff. The landing gear, therefore, is put under tremendous strain. I was talking to Mr. Sperry, who is one of the world's authorities on aeroplane accessories, and explaining to him what kind of a propeller he had to make for us, and make it quickly, which would go through this sand and cut these bushes without breaking. He said, "You don't want a propeller down there; you want a saw-mill." To meet these conditions the aeroplane has to be equipped differently than in other theatres.

A repair kit goes with each machine in service. It is much more complete in every way than an automobile kit. With it the pilot can make a great many repairs alone and unaided. Of course, in this country, where one has to make forced landings many miles away from anything at all, the pilot is put on his own resources and he has to get out of it the best way he can.

I spoke about aeroplanes being forced to get up high on account of anti-aircraft guns. These guns have been greatly developed. In fact, they are making hits now up to 16,000 feet altitude, which is about three miles. The anti-aircraft guns are usually arranged in groups of three or four and placed on the four corners of a rectangle. In the middle of this rectangle are placed range-finding instruments. The hostile aeroplanes are picked up by patrolling aeroplanes and by telescope, because one cannot see them with the naked eye. The guns have automatic fuse setters, so that each successive shot has the fuse set for the shrapnel which they fire to explode at a certain number of yards. The gun is designed to vary the range automatically. A certain number of shots are fired—usually about four—which gives sixteen shots for the group of guns. The shells burst in succession in the air and in that way cover a great area, because not only does the range change, but the area is increased by the bursting of the shrapnel, and by this means they are able to make a great many hits. They are now using 6-inch guns for this purpose.

In addition to this heavier-than-air equipment, we are paying attention to lighter-than-air equipment, and we are going to get the personnel for that in the same way that we are handling the heavier-than-air personnel.

The principle by which a balloon rises in the air and is able to keep up is very much the same as a piece of wood floating on water, the gas being lighter than the air it displaces. Of course, you know that the balloon has been used for a great many years in military work. It was used by Napoleon in Egypt, and it was used by our armies in the Civil War. The Confederates made them of ladies' silk dresses, when that was the only resource they had. It is interesting to note that Count Zeppelin, who started the building of these great dirigibles, gained his first experience with balloons in the Army of the Potomac in 1862.

The observation balloon is a captive balloon. Its under surface is built very much like the top, so that it will remain stable in the wind. They are used for the observation of field utility fire to a great extent in Europe at the present time, and communicate to the ground by means of telephone. There are various kinds of dirigibles; balloons that can be propelled from place to place. Some of the advantages are that they can stay up in the air for great periods of time; and they can hover over a certain place, while an aeroplane has to keep going all the time in order to support itself.

There are three kinds of dirigible balloons. One is the non-rigid type, which consists of merely an envelope of silk, cotton, or other fabric which contains the gas, and a number of subsidiary balloons inside of it, which may be inflated to keep the envelope properly distended, so as to offer proper suction to the wind. The advantage of the non-rigid balloon is that it is easily packed up. The disadvantage is that it is very difficult to control in a heavy wind. This shape is also used in captive observation balloons.

Another type is the semi-rigid balloon, which has a rigid part beneath that tends to stiffen the balloon and hold it in shape to a greater extent than the non-rigid type. Both these types of balloons are used across the English Channel to control the nets and to search for submarines. They, however, cannot operate in very bad weather, and they have to come ashore when it is stormy. There is also a combination of a gas-bag and an aeroplane. In fact, many of these machines have an aeroplane body or fuselage put on with a motor and a propeller. Experiments are being made in which an aeroplane is attached under the gas-bag, and when necessary it can be cut loose.

The third kind is the rigid airship, that has recently been developed and which has a number of gas-bags inside of it. So far it is a ship which is capable of maneuvering and going faster than any other kind. The difference, of course, is in having the outer envelope rigid, so that it keeps its shape all the time. The reason they have the inner gas-bags in sections is that if any one of them is injured it does not affect all of them. These have been more carefully developed than any other type of airship.

They have been experimented with for a good many years; and some have a speed of between seventy and eighty miles an hour, and are over 700 feet long and 70 feet in diameter and they have a radius of action of approximately 5000 miles, and are really marvellous structures.

The Zeppelins have the rigid envelope and various balloons inside containing the gas, which, of course, is the lifting agent. They had two cars which contain engines geared to propellers. The propellers can be turned in any direction, so, without losing much gas, the Zeppelin can force itself straight up or down, and with its engines alone it can go forward or backward. Of course, with such a tremendously long body it is difficult to turn it in short compass, but looking at it from the ground it appears to be with ease marvellously controlled.

Of course, they have all the instruments that an aeroplane has for determining the altitude, compasses for determining direction, but they are navigated mostly by radio-telegraphy. They have direction-finding apparatus which tells from what direction the oscillations from radio stations are coming and plot these data on their charts so they can tell exactly where they are. We are experimenting with that sort of apparatus.

The Zeppelins, for use over the North Sea, have over a million cubic feet volume and about 1000 horsepower. Their speed, as I have said, is about seventy miles an hour, and their length is about 700 feet. That is to say, they are over two ordinary city blocks in length, so you can see what a tremendous thing a Zeppelin is. Everybody else has tried to build them, but it is very difficult. For instance, if we wanted to build one here it would be a very difficult thing. One of the hard things is to obtain the material of which the envelope is made. It takes a very long time to develop these things, so that if people think nowadays that they can prepare after war has begun they are very apt to be fooled.

The great danger of these rigid airships is when they are landing, and the hangars in Germany are said to be made with turntables underneath them, so that when the ship comes down head to the wind the hangar—a tremendous thing, about 800 feet long—can be turned on a pivot, like a locomotive turnstile, so that the ship can head into it. Those ships are said to be able, in case of a naval attack, to get out of their hangars and into the air in about two minutes.

In the development of air service we must watch not only the heavier-than-air material but also the lighter-than-air material, and it would seem that in this country the development of these great dirigibles will be undertaken by the navy to a very much greater extent than by the army.

Now, ladies and gentlemen, that is about the extent of my remarks this evening, and I hope if you have any questions that you will ask them. I had hoped that you would ask them as I talked along, because it is very difficult for me to ascertain what you want to know in a talk of this kind.

The object that we have in view in this country is to

develop an adequate air service. We are as careful as possible in the selection of the personnel and in the construction of material. We have a corps of inspectors in every factory who inspect every piece of wood and every piece of metal that goes into the aeroplanes, and we have

not had a man killed within a year. Of course, a man is apt to be killed at any time, but in proportion to the number of casualties that everybody had before that, I feel that it is quite a record, particularly in Mexico, where we have not lost anybody.



THE NEW CLUB HOUSE *(Continued from Page 303)*

Tentative plans for remodelling the new building and connecting it with the present quarters already have been presented to the membership. These plans will be pushed through to completion so that, after the fund has been raised, there will be no unnecessary delay in beginning the work of alteration.

The Board believes that \$40,000 will be needed to provide for the alteration and furnishing of the building, which when completed will give The Engineers' Club an unusually comfortable and convenient physical plant.

Most important of the changes thus made possible will be the enlargement of the dining-room and kitchen. Another change of almost equal importance is the provision for an auditorium nearly twice the size of the present room. The third and fourth floors will be utilized for sleeping rooms, and this part of the extension will be more than self-supporting.

Still further improvements will result from the addition of rooms for parlor, lobby, and lounging purposes; provision for new cloak-rooms, serving-room, and cold storage, and possibly for billiard- and card-rooms.

Special attention is being given to the question of accommodations for ladies. At present the facilities for caring for wives of the members are not entirely satisfactory, but the Board hopes to make adequate provision in the enlarged Club House.

It is hardly necessary to recount at length the manifold advantages which accrue to the engineers who are members of this Club, or to emphasize again the additional privileges and conveniences which will be made possible by the enlargement of the organization's quarters.

Once the new building is available the Club will more than ever stand out as the real headquarters of the profession in Philadelphia—one of the largest centers of engineering in the country. The process of alteration and enlargement will provide a structure entirely befitting the dignity and reputation of the Club and the city.

Regarded purely as a matter of business, no more profitable investment than a subscription to this fund could be made by a member of the Club. Dollar for dollar, The Engineers' Club makes larger return on a member's investment than any other club in the city. For fifteen dollars annually The Engineers' Club provides advantages which in any other organization of similar standing would cost from forty dollars upward.

With the expenditure of this new fund of \$75,000, the total property investment of the Club will be in excess of \$160,000. It requires no expert accountant to figure the immensity of the return to the member for his annual payment of dues.

By making a subscription to this campaign fund, the member will work another considerable economy. Interest on bonds and mortgages, if that method of financing the development were adopted, would have to be paid every year over a long period. By making a direct pledge to the Building and Equipment Fund, the member will save his individual share of the accumulating interest fund, which will be necessary if the money be raised in any other way, and the Club itself will be able to divert to constructive purposes the large sum which otherwise must be put aside each year to meet interest charges.

But regardless of financial reasons, the Board need advance no other argument for asking subscriptions from the membership than that the enlarged Club House will make possible in increasing measure that close and intimate contact between members of the profession which is the most valuable service the Club can render. The new accommodations will tend to draw to the Club a larger number of members than ever before. Larger and more frequent meetings will be practicable with the creation of improved auditorium and dining-room facilities. Still more than heretofore, the leaders in the engineering world will be brought to the Club, where the members will have an opportunity to discuss with them the vitally important problems of this most important of professions.

Every engineer knows what can be accomplished by means of organization and coöperation. These have been leading factors in every big engineering undertaking. And that by the exercise of these factors the present campaign will be made completely successful, no one who is acquainted with the past record of The Engineers' Club of Philadelphia will for a moment question.



SOCIETY OF AUTOMOBILE ENGINEERS

PENNSYLVANIA SECTION

JOHN W. WATSON, Chairman

A. K. BRUMBAUGH, Secretary, Autocar Co., Ardmore, Pa.



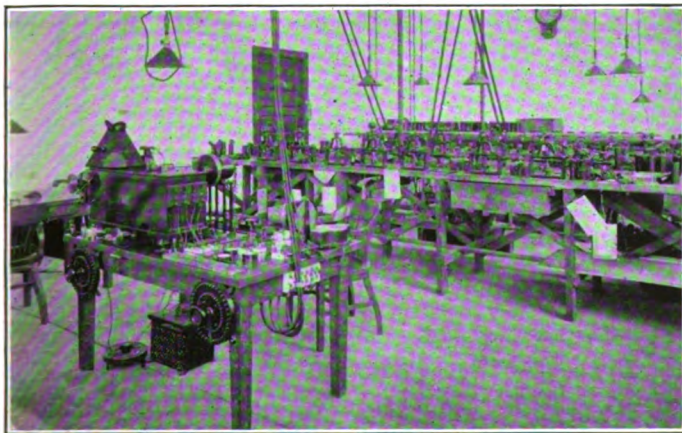
PROBLEMS IN IGNITION DEVELOPMENT

BY H. E. RICE

TO the man or men responsible for the design, production and sale of automobiles, the problem of ignition is but one of many technical problems involving lubrication, carburetion, motor transmission, heat radiation and frame design, together with many non-technical problems, such as body design, seating arrangement, trim, finish and comfort accessories. All of these must be balanced and weighed by the judgment of the automobile designer, and he is permitted but very little opportunity to delve very deeply into the problems entering into any single factor in his design. For him to attempt this would be fatal to his larger responsibilities.

The automotive designing engineer is a sort of trail blazer—his constant striving for better performance in spite of rising costs; for greater simplicity of mechanism, has been the spur to urge each particular parts maker to his utmost efforts in the rapid development of his particular part. The chief engineer or the designing engineer is the ringmaster who snaps the whip of competition over the star performers as well as the chorus.

I repeat—ignition is but one of many factors—it represents, say, one per cent. or less of the total cost of the complete car, and so long as it is satisfactory it is to the automobile manufacturer or car owner but one per cent. important. But it is within its power to be 100 per cent. important to the operation of the car, and therefore, like some of our public officials, it becomes important only when it goes wrong.



AN IGNITION DEVELOPMENT LABORATORY. ELECTRICAL RESEARCH SECTION

Thanks to the amount of development work, stimulated by the greed on the part of the designing engineer for more performance and less price—despite increasing

speeds, more cylinders and poorer gasoline—ignition development has more than held its own in this period of the most rapid development in engineering history.

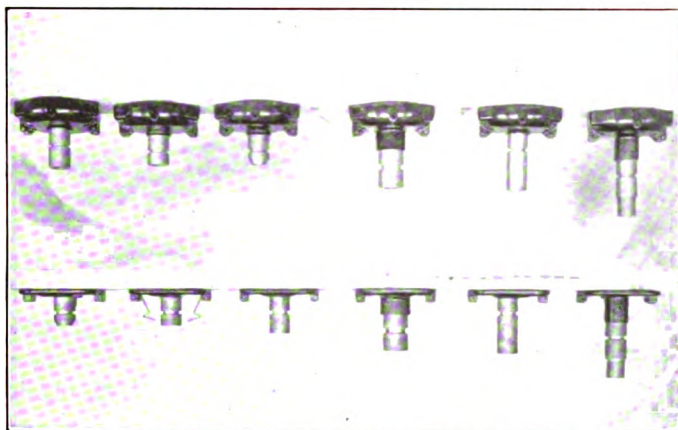
To discuss a few of the problems involved in the simple and efficient ignition equipment now obtainable—some of the problems already solved—and a suggestion of the work yet to be done, is the object of this paper.

The rapid development of high speed six, eight and twelve cylinder motors during the last two years has been made possible largely because ignition development has a little more than kept pace with the development of other details, and that we now utilize motor speeds in excess of three thousand r.p.m. where a few years ago one thousand revolutions was considered high speed is largely because of this fact. No matter how much better valves, manifolds, etc., are designed—no matter how much reciprocating parts are reduced in weight—no matter how much better balanced, the motor is obviously limited in its speed to the critical speed of ignition equipment. No matter how perfect your motor, its good or bad behavior depends largely on the constancy and dependability of that little spark which represents a very minute quantity of energy, and the duration of which is but a thousandth of a second.

To briefly summarize the early history of ignition development, you doubtless know that the first ignition used for automobile motors was of the so-called battery type. It was as much like the present day equipment as the first curve-dash Oldsmobile was like the four, six, eight or twelve cylinder roadster of to-day. The first and most commonly used ignition system consisted of an ordinary induction coil with a series vibrator arranged so as to produce a stream of sparks when the primary circuit was closed. A separate coil was connected directly to the spark plug of each cylinder, and a commutator or low-tension distributor was used for cutting each successive coil into the circuit in the proper firing order. It is rather amusing to think of the complication of circuits and parts which would result from the application of a system of this sort to a modern eight or twelve cylinder motor. In those days, however, four cylinders were considered a lot, and this early ignition equipment was effective, even if somewhat fussy and complicated. There was no criticism of its spark heat nor of its performance, so long as it performed. The big difficulty was to keep it performing and in proper adjustment. At this particular period in automobile development, electric lighting and starting equipment was undreamed of, and

the source of current was at first a set of ordinary dry cells, with sometimes a storage battery which was charged when off the car and recharged from time to time from an independent source of current.

This vibrating coil type of ignition naturally consumed a great deal of current, with the result that the life of a set of dry cells usually averaged from 250 to 400 miles, and therefore, when the high-tension magneto was developed abroad and began to attract attention along in 1907-'08 it was enthusiastically welcomed in this country, and in about two years had practically displaced the cumbersome battery coil vibrator system.



SHOWING GREAT VARIETY OF SHANKS NECESSARY TO FIT ONE TYPE OF IGNITION DEVICE TO DIFFERENT CURRENT DESIGNS OF MOTOR

The magneto was unquestionably superior to its predecessor. While it was, and I might say still is, complicated internally, it was self-contained, and the electrical end of the system was very much more direct and simple. With the vibrating coil a constant time element was always present between the close of the primary circuit and the production of the spark. At very low speeds the engine crank might travel 20° during this time element, and obviously at twice the speed it would travel twice as far, so that it was necessary to shift the spark over a wide range of advance and retard to compensate for the so-called lag, which was not present in the magneto. Also the magneto produced a single spark of greater intensity than any one of the stream of sparks produced by the vibrating coil system. With all of these points in its favor, the magneto logically became very popular, and was indeed a step forward in the problem of ignition.

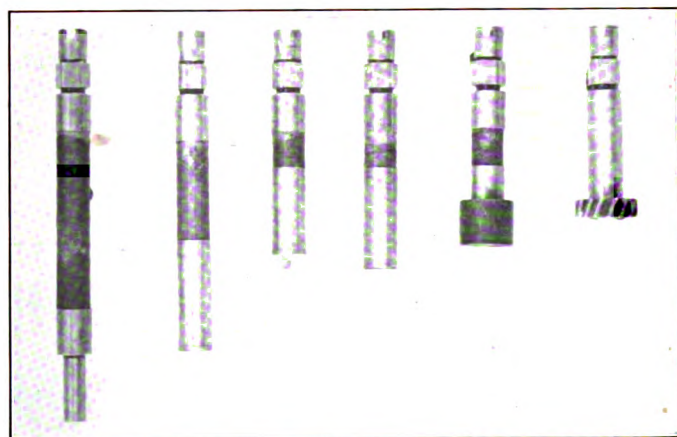
In some respects, however, the magneto did not make as good a showing as the older vibrating coil system. For instance, at a certain minimum cranking speed the magneto ceased to generate sufficient current to jump the spark plugs, while with the older battery system the stream of sparks produced in each cylinder was, if anything, hotter than at high speeds, and due to the stream of sparks a sufficient amount was liberated to assist somewhat in overcoming starting difficulties. As a result, there have come into use so-called dual magneto systems, in which the contact-making device and distributor of the magneto were used in conjunction with a vibrating coil

and battery so as to effect a combination of the old system and the new, with their resultant advantages.

This provided a hot spark or stream of sparks for starting and for low engine speeds, but resulted again in considerable electrical and mechanical complication. It is only just, however, that credit be given for the very satisfactory performance of the magneto at moderately high speeds and also to the excellent standard of workmanship evidenced in some of the higher trade magnetos in the last six years. For motors limited speed range, in which no spark is required at less than one hundred revolutions, where the high speed does not exceed two thousand, and where the power plant is not electrically equipped, the magneto is an eminently satisfactory ignition source.

Almost immediately following the adoption of electrical equipment on pleasure cars, the advantage of the practically constant voltage generator and battery equipment as a source of current began to attract attention.

Up to this time there was but one concern in the country which had carried on the development of separate source ignition equipment, and this company fought with heavy odds against a mighty combination of magneto manufacturers for popular approval, but as soon as it was possible to have confidence in the mechanical integrity of the new generator and storage battery equipment on cars, its use as an ignition source followed logically, and to-day out of a total of 109 manufacturers of cars, 87 use battery ignition exclusively, and 22 use magnetos—furthermore, many of the 22 use dual magneto systems, so that they might be said to use semi-battery ignition.



SHOWING A FEW OF THE SEVERAL SHAFTS REQUIRED TO ADAPT A GIVEN DISTRIBUTION TO VARIOUS CURRENT MOTOR DESIGNS

Considering the magneto from a fundamental standpoint, it is a mechanism which consists of a generator, a transforming and a distributing device for producing and distributing the ignition current. Battery ignition in its essentials consists simply of transforming and distributing devices without the generator.

On an electrically equipped car you have a dependable source of current that is quite independent of the motor speed. Its current is available even when the

JULY, NINETEEN HUNDRED AND SEVENTEEN

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West Indian Office, Havana, Cuba

Continental European Office, Paris, France
Canadian Offices, Montreal, Canada; Halifax, Nova Scotia

GREASE

ENGINEERS' CLUB OF PHILADELPHIA

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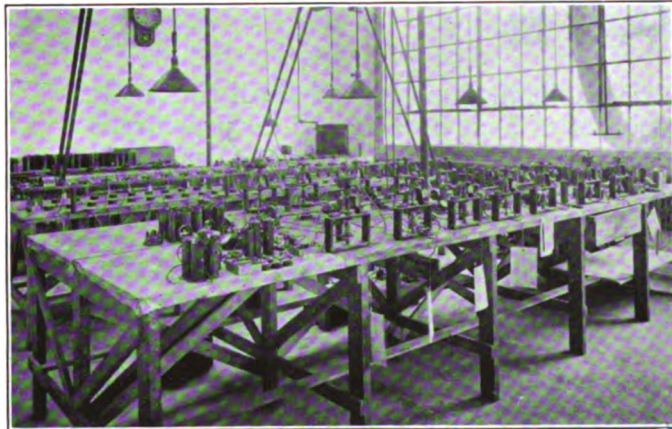
motor is not running. Therefore it is not necessary to obtain a certain minimum cranking speed at which the spark will be hot enough to ignite the usual poor starting mixture. With a battery system a full size spark is available on the first quarter turn of the engine, and is quite independent of the cranking speed.

Owing to its practically constant current source, the spark heat produced by battery ignition is more nearly uniform than with a magneto. Its value at different speeds is always more in accord with the requirements of the motor. For a long time after battery ignition began to attract attention, it was regarded rather contemptuously because it was less costly than a magneto.

Battery ignition requires fewer parts than a magneto and these parts are very much more simple in design and construction; therefore a battery ignition system of the highest possible quality in both workmanship and material will be less expensive than the cheapest magneto.

In the conventional magneto design, the entire electrical system—generator winding, condenser and contact-maker—was all carried as a part of the armature, and magneto manufacturers are entitled to credit and respect for the problems of design, both mechanical and electrical, which have been solved. But in battery ignition we are not hampered by having a large number of moving parts, nor are we limited by having to consider both generator and ignition characteristics in the same mechanical assembly. There have been a great many other problems, however, and many of them have been solved.

The simple, practically fool-proof ignition system in common use to-day that is so obvious in its design is really the result of years of close study and careful step-by-step design. Its production in quantities has been a



ELECTRICAL RESEARCH LABORATORY. BENCH TEST EQUIPMENT FOR OBSERVING WEARING QUALITIES OF IGNITION EQUIPMENT. EACH EXPERIMENTAL DEVICE IS MADE IN QUANTITIES AND AN AVERAGE TEST SECURED. AS MANY AS TWO HUNDRED SAMPLES MAY BE TESTED SIMULTANEOUSLY

problem of manufacture and an achievement of workmanship. Previous to the development of the automobile motor very little was known of actual ignition essentials; ignition equipment on stationary and other internal combustion motors was primitive and cumbersome—entirely unsuited to the requirements of a high speed multi-cylinder motor. In spite of the rapid progress of the last

few years, we are only just beginning to find out many of the actual facts and necessary quantities with which we have to work.

Our ignition system must produce a spark hot enough to ignite rich and lean as well as normal mixtures of gasoline vapor and air. It has not been known just how hot this spark must be—all that is known is that it must be hot enough. Fundamental rules and formula have been unavailable and the quantities involved have been so small that they would probably not have been much use anyway. Practically all of the development to date has been accomplished by slow, painstaking and expensive "cut and try" experimental work, starting only with known principles and elements.

The development of a new ignition system is not a matter of laboring to find some new and startling principle, making an experimental outfit, rushing it through the shop and having it appear on cars all over the country in a few weeks or months. It is a work of refinement—of careful research and of almost endless experiments with many hundreds of models.

Battery ignition may be divided into two general types and classified as open-circuit and closed-circuit systems. In each system the elements are almost identical, consisting simply of the combination of a low-tension circuit-interrupting and thinking device, a transformer coil with primary and secondary windings and distributing device for connecting up each spark plug in its proper order to the high-tension winding of the coil. The main difference in the two systems is in the contact-maker or interrupter.

The open-circuit contact-maker is so designed as to close the circuit of the transformer coil momentarily for each spark, the time interval being uniform at all motor speeds. It is constructed on the general principle that when a spring is stretched to a given point it will recoil with exactly the same force and at the same speed no matter how fast or how slow it was originally stretched. The device consists of a little steel trigger or lifter which engages notches cut in the rotating timber shaft, a notch for each cylinder. The lifter being pulled forward by the rotation of the timber shaft, reaches a point where it slides off, and on its recoil it rides up over the rounded part of the shaft and strikes a blow against an impact piece or latch, which in turn moves a contact arm so as to close the primary circuit for an exceedingly brief but uniform time interval. The time during which the primary current flows through the coil is approximately 33/10000 of a second for each spark. By making the resistance of the primary winding quite low, the current flow for this brief instant is quite brief (about $4\frac{1}{2}$ amperes), but the time is so short that the actual energy consumed is almost negligible—a six cylinder ignition system requires less than six-tenths of an ampere at highest motor speeds. With a system of this sort, ordinary dry cells are economically used as a source of current supply.

Owing to the fact that each operation of the open-circuit mechanism is complete and the lifter on its return stroke opens as well as closes the circuit, current flows

only when the motor is running and even then only for an exceedingly short time interval for each spark. Because of this fact there is no danger of accidental battery discharge should the ignition switch be left on. The efficiency of this type of ignition is certified by the fact that it is, and has been, widely used for the past twelve years.

In the closed-circuit type of ignition, the same elements are used except that the contact-maker is operated by direct cam action and the electrical windings are proportioned differently.

The form of the contact-maker has been evolved from that of the magneto and consists of a simple arm or lever carrying a contact point controlled by a spring to bring the contacts together, and actuated by means of a cam on the timer shaft.

By reason of this simple cam action, the circuit is closed for a larger time interval than with the open-circuit system and the duration of the contact varies with the speed—long contacts at low speeds, becoming shorter and shorter as the speed increases to the critical limit. This is a much simpler type of ignition contact-maker than is required by the open-circuit system, but it requires more current and, should the ignition circuit be left closed after the motor has stopped, the battery will be discharged at a rate limited only by the resistance of the primary circuit.

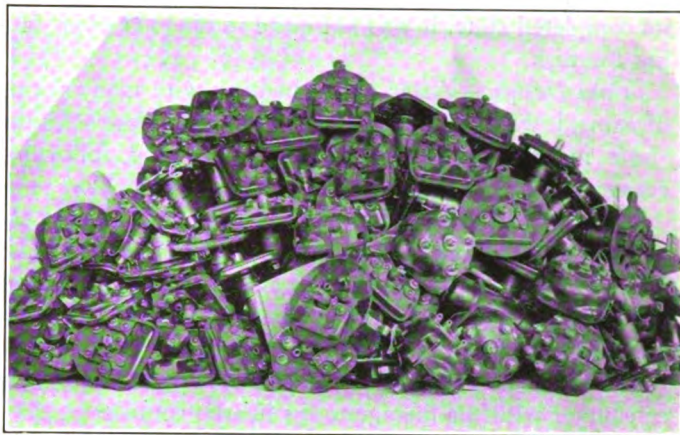
The current characteristics of the closed-circuit system are the reverse of the open-circuit, the former taking a maximum current when the motor is not running, falling as the motor starts and reducing with the speed. In the open-circuit system the current consumption is 0 at zero speed and increases in direct proportion to the speed. While the open-circuit type of ignition is widely and successfully used at present, the closed-circuit is undoubtedly simpler in construction, and its manufacturing cost is considerably lower. It is therefore in wider use than any other type.

To get a general idea of the problems in the design of ignition equipment, it may be interesting to follow the general design of a recent ignition system and see how the problems involved were met. In preparing for the design, the two factors of maximum efficiency, electrical, mechanical and functional, and the commercial factor of economical production, were of course uppermost. Naturally the first step was to carefully measure and test existing models and types and to study them fundamentally, also reviewing all of the previous development work done in this line.

One of the first facts brought out by the Experimental Department was the desirability of reducing the inertia in the contact arm—seemingly an easily solved problem. However, before a final contact arm was decided upon and produced, hundreds of them differing in minute details were made up and tried. Various kinds, shapes and sizes of control springs, many different kinds of pivots, arms fulcrumed as first, second and third-class mechanical levers—in all a huge number of separate experiments were necessary before the desired result was achieved.

Theoretically, a contact arm of one-quarter the weight

will have only $1/16$ the inertia. It will be very much easier to start moving, and very much easier to stop after it has started. Consequently, the lighter contact arm will follow the cam more closely and require less spring tension. This in turn reduces wear and lessens the hammer



A PILE OF CONTACT-MAKER NUMBERING OVER TWO HUNDRED—PART OF THE SEVERAL HUNDRED DIFFERENT EXPERIMENTAL MACHINES BUILT BEFORE THE EVENTUAL DESIGN WAS PERFECTED

blow of the contact points and a consequent tendency to bounce when striking. Again, a further advantage in performance was obtained by reducing the distance over which the contact arm traveled. This was done by reducing the diameter and lift of the cam, and the contact arm was arranged so as to engage the cam on the end instead of the middle, thus reducing the "throw" and shortening the gap at the contact points.

Naturally the contact arm can move faster with less inertia effect in traveling six-thousandths of an inch rather than twenty; and while this reduction in the gap involved some electrical problems, these were successfully met.

Then another problem arose—one which is always involved in the design of high speed reciprocating mechanisms, no matter how large or how small—and that is the bugbear of harmonic vibration. The only simile I can think of is one which I have used before. Hit a punching bag at a given rate of speed, with uniform force—but not too much force—and you have an oscillating system that is harmonic. You will find points at which your blows exactly synchronize with the oscillations of the bag; vary the rate at which you deliver your blows, however, and the resultant behavior of the bag becomes unpleasantly erratic—not to say painful. This is of course a characteristic of all spring oscillating parts, and is a problem involved in the design of your contact arm as well as in the design of your crank-shaft.

This troublesome factor is materially reduced by a reduction in the inertia and consequently the spring control of the contact arm. Tests of several hundred various contact arms and springs finally led to the development of one so arranged as to slightly change its fulcrum or bearing point throughout its range of movement—a sort of cantilever arrangement in miniature. This was found

to practically dampen harmonic vibration of both the contact arm and contact spring within the limits of operation of the device.

From this you can see that the solution of one problem simply opens the door to another one, and while the resultant mechanism is quite obvious when you view it in its completed state, it was not quite so obvious when facing the task.

Cam Design.—After experimenting with many forms of cams, it was decided to make this of one piece with the shaft instead of being adjustable, for the following reasons:

(1) The adjustable cam is convenient and useful only when the initial installation is made. No subsequent use is served because the ignition timing, if fixed, cannot get out of adjustment. An adjustable cam is only one more vulnerable part for the car owner to tinker with. If he must adjust his timing after the car leaves the factory he can tinker with the linkage to his heart's content.

(2) By making the cam and shaft in one piece, its outside diameter can be made small, thus reducing its peripheral velocity and minimizing friction.

(3) It can be manufactured with far greater accuracy.

(4) The construction is greatly simplified and this particular part is less costly to manufacture. After the details of the design were decided, there came the many problems of manufacture, the designing of special grinding equipment, methods of hardening, etc. It should be noted that these problems came up for consideration not after the design was completed in the experimental department, but were important factors in the design itself.

Condenser.—The condenser in an ignition system acts as a sort of shock absorber to the contact points. Shunted across the contact points, it reacts on the primary circuit at the instant the points are opened, so as to absorb the spark and render the break more abrupt. It is usually placed in the coil container, and extra wiring between the contact-maker and the coil is required because of it. Its distance away from the contact points hampers its beneficial action and increases its necessary size and capacity. Surprisingly little is known about condenser and condenser design from the standpoint of spark absorption, and in order to solve the problem of this particular contact-maker design it was necessary to study condenser fundamentals to a much more elaborate degree than had previously been done.

MILITARY BOOKS FOR ENGINEERS

A. MILITARY POLICY, CONDUCT OF WAR AND MILITARY HISTORY

The following abbreviations are used: Supt. of Docs., Superintendent of Documents, Government Printing Office, Washington, D. C. Book Dept., Book Department, Army Service Schools, Fort Leavenworth, Kan.

1. OFFICIAL BULLETIN, Vol. 1, No. 2, Office of the Chief of Staff, Washington, D. C. (Especially pp. 21-39.) Publisher: Army War College, Washington, D. C. Free. (An official outline of the theory under which our forces are to be organized and administered.)

2. MILITARY POLICY OF THE UNITED STATES. Upton. May be obtained from Supt. of Docs.; paper, 50c.; cloth, 65c. (A most valuable and comprehensive review of this subject.)

3. FIELD SERVICE REGULATIONS, 1914. May be obtained from Supt. of Docs.; 60c. (A condensed official statement of principles, methods and details of military operations.)

4. ELEMENTS OF STRATEGY. Fieberger, Publisher: U. S. Military Academy, West Point, N. Y. May be obtained from Book Dept.; 75c. (A short outline, with historical illustrations.)

5. CONDUCT OF WAR. Von der Goltz; translated by J. Dickman, Hudson Publishing Co., Kansas City, Mo. May be obtained from Book Dept.; \$1.70. (The standard work on this subject, covering generally the same ground as 4, but more abstractly and elaborately.)

6. ON WAR. Clausewitz; translated by J. J. Graham; 3 vols.; K. Paul, Trench, Trubner & Co., 1908. May be obtained from Book Dept.; \$6.60 (including postage and duty). (The greatest classic on the subject; a complete analysis of the

phenomenon of war, and profound discussion of the mechanism thereof. Written early in the 19th Century, it is still the foundation of modern military theory.)

6½. THE NATION IN ARMS. Von der Goltz. May be obtained from Book Dept.; \$2.50. (An excellent modern work on war; less elaborate but more readable than Clausewitz.)

7. AMERICAN CAMPAIGNS. M. F. Steele; 2 vols. Publishers: Byron S. Adams Publishing Co., Washington, D. C. May be obtained from Book Dept.; \$4.50. (In addition to careful historical surveys of all the campaigns from the Colonial Wars to the Spanish-American War, these lectures give extensive and valuable comments as to the military principles.)

8. A STUDY OF ATTACKS ON FORTIFIED HARBORS. Rodgers; proceedings Nos. 111, 112 and 113, United States Naval Institute, Annapolis, Md.

9. LESSONS OF THE WAR WITH SPAIN. Mahan. Publishers: Little, Brown & Co., Boston, Mass. May be obtained from Book Dept.; \$2. (Of special importance, as showing the true relation between our coast defense and our navy.)

10. REPORTS OF MILITARY OBSERVERS ON THE RUSSO-JAPANESE WAR. Part III, J. E. Kuhn. May be obtained from Supt. of Docs.; 60c. (In addition to an account of operations, this report contains valuable information as to fortification and siege work, organization and equipment.)

11. ORGANIZATION AND OPERATION OF THE LINES OF COMMUNICATION IN WAR. Furse, 894. Publishers: Wm. Clowes & Sons, Ltd., London. (An old but comprehensive survey of this subject, with much historical information.)

(Continued on Page 342)



AMERICAN SOCIETY OF MECHANICAL ENGINEERS .: PHILADELPHIA SECTION

LEWIS F. MOODY, Chairman.

JOHN P. MUDD, Secretary Midvale Steel Company, Nicetown, Pa.



THE ENGINEERING OF MEN

A TALK BY WILLARD BEAHAN

AT A JOINT MEETING OF THE AMERICAN SOCIETY MECHANICAL ENGINEERS, ENGINEERS' CLUB OF PHILADELPHIA, AND AFFILIATED SOCIETIES, MAY 22, 1917

"The most difficult and at the same time the most important branch of engineering is the engineering of men."

I SHALL speak of the engineering of men to-night mainly from the standpoint of the engineer and as a member of this society. If one endeavored to speak of the problems of labor and capital, this hour would be all too short. As a caption for this paper I use a law laid down by Robert Stephenson, one of the fathers of engineering. That statement is nearly a century old. Robert Stephenson was the son of George Stephenson, who was the father of railroad engineering, and who built the *Rocket*. The first locomotive that was run in this country was built by Stephenson and his companions. In those days civil engineering was not at all subdivided. We had civil and military engineering. We did not have any division between mechanical and civil engineering.

George Stephenson built the *Rocket*, as you know, in 1826. He had become prominent as an engineer of railroads, inventor, and promoter. He really became the first railway engineer of the world. Now this George Stephenson laid down a law some hundred years ago and we have not yet reached to the horizon of that law. It is this: In speaking of the means of transportation, he said:

"Competition is impossible wherever combination is possible."

You put that law alongside the law which I have first laid down, given by his son, and you have shown the engineer of to-day his two largest problems, and you have given a horizon in each of those problems which is broader than many of our visions can compass. George Stephenson did not live a great while after the *Rocket* was built, but his son, Robert, lived a long time, and it was in the later years of his life that he laid down this first rule for us. I want to call your attention to this fact—that these fathers of engineering, father and son, and the men of their time, not only made the plans of their engines, of their bridges, and their roads, but they promoted the project through Parliament and before Boards of Trade. They raised the money; they built the roads; they handled their own men; and they completed the work.

That was the way our profession started. As we grew, and especially in America, the development of the country was such that our profession could not possibly keep pace with it. The result was that, more and more, that

part of engineering which could be lopped off was taken away. The legal end, the promoting end, the financing end were the first to go. Not so many years ago, I can quite easily remember it, contractors came to be general in this country—we still have with us a few of the engineers who never employed contractors. Capt. James B. Eads, who built the St. Louis Bridge, the steel arch of which is the biggest steel arch, I think, in the world, was foremost among those who promoted that bridge. He convinced the people it could be built, that it ought to be built, and he convinced Congress. Mr. Eads, to a marked degree, prosecuted his work in this country as Stephenson did in England. Gen. Grenville M. Dodge, who commanded the Sixteenth Army Corps during the war, and made a mark for himself with Grant for his rapid construction of bridges, was also a great railroad engineer. It was my privilege to serve under General Dodge in the 80's in Texas. To a large extent, he planned, financed, and completed his own works through improvement companies, which were really the general contractors.

I maintain to-night that we have drifted too far away from the ideals of the fathers in engineering, and that all this is because we were driven to it. It came to pass, not many years ago, that about all that an engineer did was to make the plans, drive stakes, and let the contracts, and we have finally come, my brethren, until, as a prominent labor man lately said to me, "that about all that a railroad company can say now in labor questions is to pay the bills."

We have drifted so far away from the ideals of the fathers that we are of much less use to the world than we should be, and I wish to say that this society saw that a few years ago, and the very fact that we are domiciled in the Chamber of Commerce is evidence of our new vision. The making of a plan, the letting of a contract, and driving some stakes, which are followed more or less closely, is not the highest form of engineering; and if I do not say anything else to-night that you young men will remember, I want to say that we are not coming up to the ideal of the Stephensons. We have spent too much time in testing materials, and work of that nature, and we have spent very little time in engineering the men. We have turned that over to the men with thick shoe soles, brass

watch chains, and heavy voices. The most important branch of engineering is the engineering of men, and that is the branch that we have turned over to other people.

GENERAL LAWS

The first law I would lay down in the engineering of men is a very old law, but in my judgment it is fundamental. Some call it the Golden Rule. You will find it in the 6th chapter of Luke, along about the 31st verse. Freely it reads:

"Do unto others as you would that they should do unto you."

As engineers, we have gotten a good way from that. We have found out, I suppose, that it takes quite a brave man to lay down that rule in the handling of men; but when as an employer of labor, or a supervisor of it, I forget that law and fail to treat those men as I should like to be treated, I am bound to have trouble.

The second law is that very good one of the army officers of West Point, and is compassed in that little phrase they term "caring for their men," meaning looking after their needs, their wants, their happiness, their welfare. I would place that alongside of the Golden Rule. An army officer, be he never so brave, is not a success if he neglects to take care of his men. The high-water mark of warfare on this continent was at the battle of Gettysburg. In Pickett's charge, General Hancock, with the Second Army Corps, was withstanding that charge. Hancock was wounded a few minutes before Pickett started, and he was wounded while writing on the horn of his saddle an order to his commissary to bring up fresh meat for his soldiers for supper that night. Even in the awful stress of that critical moment, Hancock cared for his men.

I think that bears me out that the care of men is one of the first laws to be observed in the engineering of men. I have heard many men from West Point say: "We have many men who can *fight* a brigade, but fewer who can *handle* a brigade." It is easier to lead a charge than it is to take care of a brigade two weeks. In the engineering of men this is the second principle I would state.

The third law which I would have you remember is this: Men carried on your pay-roll must be carried on your heart. Whether you pay the men or not; if you have to sign the roll on which these men's names go in, month by month, you must carry those men on your heart. You are responsible for their welfare, you are responsible to see that they get their pay, the last penny—and even a little further than that—the last penny that *they think they ought to have*. You are responsible to see that they get their money in time; that they are promoted; that their rates of pay are equitable, especially of the younger ones. More than that, you are responsible for the married man, especially. If he is a father, so far as you can, allow him to work as near home as the interest of the company will permit, if it does make you a good deal more trouble. That is what I mean by carrying them on your heart. If you don't do that you are not an engineer of men. If you don't do that the Almighty will some day call on you to

know why you did not. If you did that there would not be so many strikes.

PRINCIPLES IN ORGANIZATION

In the organization of your work and blocking it out, there are three things of prime importance: Personality, organization, and treatment. If I may reverently paraphrase—"There abideth personality, organization, and treatment, these three, but the greatest of these is *treatment*."

The personality of the superior at the head of an organization is a very important matter. The bigger the organization, relatively, the more important it is to have the right kind of man, but even if there be but one gang of men, the personality of that gang boss is very important.

In an organization, I believe in military ideals. If you can imagine a military organization without the shoulder strap, then that is what I believe in, and I have worked with army officers a great deal. There must be discipline, there must be responsibility placed upon one head, and it must be recognized. If you cannot respect the man above you, you must at least respect his position. Don't forget that. That is the army idea.

It does not follow that the ranking engineer of an organization is the best engineer. Let me illustrate: We were building the Texas Pacific in the early 80's, and as these men have passed away I can mention them. One of the men, Major Washburn, a West Pointer, was in the artillery at Little Round Top at the battle of Gettysburg. There was at Fort Worth, Texas, where we had our headquarters, a Major Patton. I think he was a Kentucky major, I do not think he ever was in any army. (Laughter.) There was in our organization a Mr. Lawrence, who had seen splendid service on the Union side and was a very brilliant, brainy locating engineer, but sometimes given to drinking too much. He happened to be in Fort Worth, and I suppose had been drinking, and said one night that he was a better locating engineer than Major Washburn. Major Patton heard this remark, and he, wishing to curry favor, said to Major Washburn: "Major Lawrence says that he is a better locating engineer than you are." Major Washburn replied: "I believe that is true." Whereupon the Kentucky major said: "Why, do I understand that you would have a man under you who claims to be a better engineer than you are?" "Oh, yes, I am very glad to have them. I wish I had more of them. Now, for instance, there is Mr. McL., who is a better construction engineer than I am; Mr. L., who is a better maintenance engineer." "That is all very strange," said Patton. "No," said Washburn, "they are all better engineers than I am, but I suppose that the people in New York, General Dodge, the president of our company, consider that on the whole *I am the best man for chief engineer*." He was the best all-around man. He was quite good in all departments. He was a fine organizer. He knew how to handle men.

The worst mistake we make to-day in organizations is experimentation. In railroads it is pitiable. I saw but a

few winters ago, in *The Railroad Gazette*, an entire page occupied with the reorganization of a certain railroad in a certain way and giving the reasons for it. On the next page, another road, it was announced, was reorganizing from the organization which the first road were abandoning, as they were instituting something else. One company or the other was making a mistake. One company should not have abandoned it, or the other company should not have taken it up. We are in the kindergarten stage, so far as that is concerned. We men in railroad service know it means a great deal of expense, a great deal of distress, and it takes us a long while to get our bearings.

The third great requisite in organization is treatment. I think if we could get back—which we never can—to the English idea of master and servant, we would be doing something very much to be desired. It would save us a great deal of money and do away with a great deal of friction. The master and servant idea was this: A man hired a boy, took him into his family, fed him, looked after him, paid him, and he lived with that boy for a term of years. We cannot do that now, but some one must come pretty near doing that for us. We must pick out the men to whom to delegate it. I suppose that many of you think that it is entirely visionary and impractical. No, it is not. The Chicago and Northwestern Road has come very near that idea to-night, because Mr. Hughitt, chairman of the Board, believes in it. Here is Mr. Hughitt's rule: If a man has been in the employ of the company five years he cannot be discharged without a hearing. If the charge against the man is incompetency, Mr. Hughitt would say, "It seems to me it has taken you entirely too long to find this out," or, "You should have found it out before five years." That applies to even such minor positions as brakeman. If a man thinks he has been improperly used on the Northwestern he can appeal to the President and the President investigates. When I was there I said to my informant, "I should think it would take all the President's time." He said, "Oh, he doesn't get so many cases. We all give heed to that." (Laughter.) Good treatment will win devotion. A raise in pay will not quickly win devotion. We think if the company would only allow us to pay bigger salaries, we would get and keep the best men in the country. There is no greater fallacy. It confesses our weakness.

ENGINEERING ORGANIZATION

The simplest form of organization is that for the project engineer. The first requisite, in my judgment, is to put a man in charge of that project with engineering education, whether he acquired it in college or somewhere else. I do not believe in putting a man on a job who has not been in that particular kind of work. I do not believe in putting him in charge because he is simply brilliant. I would put a man in charge of that work who has had experience in that kind of work, and I want him to be forty years of age. I was put in charge at twenty-five. He must know human nature. He must be in full charge of all the features of the work.

"Well," you will say, "that is difficult." Very well, there is the first difficulty you are going to meet. If you divide the responsibility at all, then when there is a mistake made there is no one you can hold responsible. Your chief of party should always be able to do any work under him fairly well. In order to do that, he must practically come up through the ranks. His first assistant must be but a little less able. He must be an understudy. In temporary illness he must be able to carry on the work. There should always be an understudy in *every position*, so far as that is concerned.

Allow me to say in parentheses that I have a great sympathy for young men whose fathers are vice-presidents or large stockholders. I am not one of those who degrade that kind of man. I have seen some sad things in that direction. Don't make the mistake of putting him on work he cannot do, and then hiring another man to do the work. You are trying to curry favor and build yourself up at the expense of that young man just because his father is vice-president. I have had more than one young man come to me and beg of me not to let the men know his father is vice-president. Plenty of men in this country are handicapped by their wealthy, or their great, fathers. I am sorry for them.

Have your office for this project or piece of work in the middle of your work. If it is a piece of construction work, have your best assistant in charge of the office, never the chief clerk. This has been the day of the chief clerk, and he is passing. The rubber stamp and the chief clerk have cost many a heartache and many thousands of dollars. It comes from the fact that you and I in charge of the work are overloaded and are jealous of our understudy. "If we get a good assistant, he will get our job," we think, so we put a chief clerk in and somebody else gets our job. Our centralization is killing us. It killed Harriman. You will rule your work—this project I have outlined for you—if you rule it at all, by reason of your engineering and your manhood. If you are that kind of man, it is easy to control the project and have your success.

The heads of even the smaller engineering projects or enterprises must "sit tight." Troublesome times will come. With your work well lined up and the best engineers and labor there will come times that try men's souls. Then you need to have faith and the staying qualities of the heroic sergeant of whom Kipling says:

He's just as sick as they are,
His heart is like to split,
But he works 'em, works 'em, works 'em
Till he feels 'em take the bit;
The rest is holding steady
Till the watchful bugles play.
And he lifts 'em, lifts 'em, lifts 'em.
Through the charge that wins the day.

LABOR PROBLEMS

The engineer of men in the broadest sense must be twofold, an engineer and a student of men. An engineer of design is not an engineer of men. He is an engineer of plan, specifications, and of material. An engineer on

the frontier, as General Dodge told us, had to be engineer of men, or the Indians would get him and his men both. (Laughter.) The man, I have said, who is in charge must have absolute charge, and in the control of men—that is the first thing.

If you expect to control labor in general—and I am now speaking of ordinary labor—three things are necessary: First, there must be no dispute but what you have the authority, and the men must know that. You are in authority, you are the boss, if you are handling men, whether a few or a few hundred men. Battles have been won by a poor commanding officer, but no battle was ever won by a debating society.

A second requirement is that you must be absolutely right—legally, morally right. That the right is on your side and beyond dispute. I can best illustrate my meaning by an incident.

In 1898 I was superintendent of the Cascade Tunnel for Mr. James J. Hill, of the Great Northern Railway. It was a company job. I was superintendent, another man was engineer. We went up there in August. We started in with no organization and no men; cleared the ground, got a few men at a time—we gathered there four hundred men—driving the tunnel two and three-quarters miles, working from a camp at each end. We boarded the men. We had our own store, and our own doctor and hospital—a little community by ourselves. There were some saloonkeepers who came in—we held them off our certain reservation. We made our rules that applied to them. We had our own camp bosses. There was a county line crossing at the center of the tunnel and each of the camp bosses was sworn in as a deputy sheriff in his own camp county. They had been peace officers at home. While all the men did not know it, I was deputy sheriff in each county. When a man got bad, we locked him up, and wired for the sheriff to come and get him.

The incident I am about to relate happened in February. I had not been put in charge of the dining-rooms. We had an engineer in charge of the maintenance, and, thinking the work would be heavy for me, the dining-rooms were still in his charge. He had put there as commissary clerk a conductor from the dining-car service. Now, of course, he would not know how to feed *these* men. He got us in trouble. The snow was very deep, lying twenty feet on the level. The only trails were where we walked. There was no such thing as straying out of the path. The men did not know I was in that particular camp. I had just passed the dining-room—our men worked in three eight-hour shifts—I saw the men coming out of two of the company's quarterhouses. There were one hundred men. It was snowing very hard. I suspected they were coming out for mischief. They came up the trail, going toward the dining-room. I waited for them:

"How are you, boys? Going up to the dining-room? A little early for dinner, aren't you?" This was about half-past two, and the next meal was at four o'clock.

"Yes, but we have a little business up there," one of them said.

"Well, am I invited?"

"I don't know about that," was the reply.

"What's going on?" I asked.

"We are going up there to hang the commissary clerk." (Laughter.)

"Oh, well, I don't think it is very polite of you to neglect to invite me when there are such festivities as that. What's the matter with the commissary clerk?"

Really, it didn't amount to anything. I asked them some questions, got all the facts.

"Now," I said, "do you think you are treating the company right to create a scandal of this sort, as it will do? Aren't you acting like fools here? Now, suppose I let you go up there and do it, which I am not going to let you do, you can't get off this right-of-way without we allow you to. The snow is twenty feet deep, you can't walk down the track. We will load you up and send you down to Seattle; a lot of you will get hung. Another thing, how will this look when it gets to St. Paul to-morrow morning? Is that treating the company right? You are supposed to be American citizens. You think you are fit to be citizens and voters in this country. This man hasn't done anything. Do you think you are treating me right? I am the superintendent out here, and I am responsible."

"Well, we ain't got anything against you."

"Yot. haven't! Now, you fellows go back into your 'quarters,' and if you have a grievance I will listen to you, and if you don't, I will have to strike first."

I talked to them pleasantly, reasonably. Some eighty men in the background wandered back. They hadn't anything against me. They didn't want to be hung. The leaders wouldn't stir. I suppose there were some ten to fifteen of them. I could not do anything with them. The first leader I knew very well. I had routed him once before, a Cornish miner, surly and thickheaded; another was an Irishman, my own nationality. No use to argue with those men, they were beyond argument. There they were, the snow was coming down pretty lively.

"Now," I asked, "have you got anything more to say? You fellows go back to your bunk-house." Not a man moved. I drew my toe across the path, and stepped back a pace or two. "That is all I have to say; come ahead, you can kill me at the last, but just as sure as you cross that mark I will kill six of you, and I think I can pick out the six who started this, and I will kill them first." They looked at me for a minute or two, and the Irishman said:

"Well, now, 'Super,' what is your proposition?" I said: "You go back to your bunk-house just as I have told you a dozen times, and in twenty minutes you send a committee around to my room at D quarters and I will tell you what I will do." They went back to the bunk-house. Then I went back to the cook-house and saw the commissary clerk. In twenty minutes I met their committee, as agreed, and said:

"Now the main trouble is too small a cooking range; I will have another here as soon as I can."

"That is all right; we think that is fair," they said. That ended it.

Having the authority, and being in the right, the final thing in handling labor is that you must not be afraid. Let a hundred men come together, average men, and it is said that in thirty days one of that hundred men will be the leader. Now, I never knew a leader of that sort to be a coward. So, as an engineer of men, you must have that leadership quality. You will be surprised to see what you can do with it. I believe many of us fail right there. We are afraid. Afraid of the law; afraid of damages; physical fear; fear something is going to happen to us. Right makes might more than we think.

May I again illustrate from experience?

We were building the Texas and Pacific Railway for Mr. Gould in the early 80's. We began at Fort Worth and worked toward El Paso, the other terminal. By the time we had reached the Staked Plains, the Southern Pacific, our rivals, were nearing El Paso. We started then a second construction force out of El Paso to secure the choice of route down the Rio Grande River and up the best tributary suited to our purpose. To reach this grading, we must first build through Carizzo Pass of the Apache Mountains, 125 miles east of El Paso. Though but a youngster then, I was resident engineer of the work for ninety miles, including the pass.

We had been at work some five months at the time of the incident I now relate. The pass could be traveled into or out of at the ends only. At the upper end was a grading camp of about one hundred men—mostly Irishmen. At the lower end was a camp of a little greater number of Mexicans. In the center and just across the grade from the engineers' camp was a camp of sixty Chinamen. They had served their time of several years to the Six Companies and were free of any obligation. They were tall, strapping fellows, entirely different from our laundrymen, and each carried a pistol.

In this cosmopolitan camp there had been no liquor in the entire five months we had been at work. The Irishmen were certainly dry. The Mexicans resembled them in that one respect. The Chinamen were hemmed in, were armed and nobody loved them. Into this canyon there drove, one summer afternoon, two big wagonloads of whiskey, accompanied by six heavily-armed men. They unhitched their teams about in the center of the pass and were neighbors to the engineers and the Orientals. This saloon outfit had been the pest of the grading on the east end for two years. The track had gotten far enough across the Staked Plains, so the proprietor got across without dying of thirst. The contractor in Carizzo Pass tried to coax him to move on west. He tried to buy him off, all to no purpose.

My work compelled me to ride nights, as the Apache Indians were bad. The next morning I reached that camp. The contractor and myself held a pow-wow, the engineer party being present. We decided what men we could depend upon and sent them word to be ready. The contractor started moving his pile of grain sacks and

piled them in a crescent and left spaces for loopholes where needed between the sacks.

I wrote out a notice stating the company's case, that the saloon interfered with our business, menaced our lives, owing to the mixed races, trespassed on our land, and that we forbid his camping there. I signed it for and in the name of the company. I again saddled up the grand old Kentucky horse I then rode, buckled my weapons around me, rode down to their wagons, and called for the boss of the outfit.

There rose up a splendid specimen of physical mankind, wearing a fine pair of ivory-handled 44-calibre six-shooters. I handed him the notice. He read it twice. As he handed it back he said: "I suppose you know I'm not going to pay any attention to that. What's more, I've heard of you and I'm not afraid of you." I was encouraged. I saw there was some force to that notice and that fear was in his mind. Meanwhile the six ruffians had gathered around me, all around. I sat with my arms folded. I told them I was building a railroad. That we could not lay tracks *around* the heavy work in that pass. That the grading was going to be done before the tracks reached it. That I was hired to see to it and that they were getting in the way. I advised them to get out of that pass. If they did not, there was no telling what night an Indian outbreak would occur and they would be sure to get hurt. I made it clear to them that I was some prophet in Apache *lore*, and they saw what I meant. Then I rode off and never looked back. In an hour they hauled their wagons some miles up above the pass and we left them there the rest of the season. I had happened to notify them in the name of the company that their business interfered with ours and did it before their camp was established, a good legal point which I blundered upon. I showed them I was not afraid and was in earnest. They fell back. They always will. In Grant's first battle, he happened to think that the enemy was probably as badly scared as he was and that the enemy's cause was less just. So, in the engineering of men, when you must cope with the lawless element, have right entirely and clearly on your side. Then sail in. If you do not run, the other fellow must, finally. If this incident should catch the eye of any of the old T. and P. men, I wish to say that that fellow could have been tamed two years before, *I think*, and by the same method.

A labor union is not omnipotent. If you will read in the last *Century* for May, in "The Topics of the Times," you will find that no one claims any more than 25 per cent. of the labor in this country is organized. They tell you, too, that a labor union must have its own way and that the minority of labor must rule the majority of labor. Personally, I am ashamed of the way we allow labor unions to dominate us to-day. I think I see the turning of the tide. Labor unions are not at all what they were five years ago, and, unless I mistake not, we are going to see much less trouble with labor unions than we have had. It is a fact determined by the Commissioner of Commerce in the East that 10 per cent. of our labor is idle all the

time; of the 90 per cent. employed, one-third is idle some part of each year. That is a sad thought. I believe honestly that what we need in this country to-day is not higher wages, but steadier work. I believe that labor unions are working in the other direction. What they want is higher wages and more men put on for a part of a time. The ironclad pay-roll—by that I mean uniform pay-roll—has worked great mischief in this country, and, in my judgment, is a confession of weakness on the part of the employer and engineer. Why should we pay an Italian laborer, who cannot understand our language at all and who is undersize, as much as we pay a Scandinavian or German, who speaks our language and who eats as much as anybody? (Laughter.) Is there any sense in it? We do it to save trouble. If you are like I am, you do it because you are too lazy to do anything else.

Now, I ran against this ironclad pay-roll idea, when a youngster, in Texas. We had been building the Texas and Pacific, and the farther we got away from Fort Worth, the poorer our engineering employees were, because other roads came in and took our best men. It was necessary to do something, or our work would be badly crippled. They brought me back to Fort Worth, to build toward Denver. I spoke to the Chief Engineer and said: "Let me fix the rate of pay," and explained my ideas. He said: "I fear you will have trouble; but, all right, try it out." I did; I worked for the company seven years after that, and I always fixed the rate of pay for engineers under me. I always kept the best men, the poorer men I did not give so much. On the average, I paid less than the company gave. I would start the new men at the lower rate of pay. I said: "I can raise you, and if you think you are not being paid enough, tell me." When I

handled engineering parties I always fixed the engineers' pay, and *I never had an engineer quit nor ask more pay or less work.*

In recapitulation I would say that as engineers we have drifted from our moorings. We must get back to the view of the Stephensons and the fathers of engineering, and not only be engineers of design, but engineers of men. To do so, two things are necessary: The courage of our convictions and a knowledge of the teachings of the Carpenter of Nazareth, 1900 years ago, "Love your neighbor as yourself." Now, your employee should always be your *near* neighbor.

The military organization is a good foundation, and coupled with it is the broad law of the army officer to "care for his men."

Strikes are blind barbarism and economic waste. Engineers can do more to prevent and more to stop them than any other class of professional men. It is our duty. Shall we then be men of affairs in this as in so many other ways now? The present time is most opportune. The labor strike is failing and passing. May we, as engineers, inherit our own kingdom and bless mankind? May we take upon our shoulders this phase of the white man's burden? I commend to my brother engineers these lines of Foss as our watchword:

There are hermit souls that live withdrawn,
In the place of their self-content;
There are souls like stars, that live apart,
In a fellowless firmament;
There are pioneer souls, that blaze their path,
Where the highway never ran;
But let *me* live by the side of the road
And be a friend to man.

MILITARY BOOKS FOR ENGINEERS

(Continued from Page 336)

B. PERMANENT FORTIFICATIONS

(The references given cover chiefly the principles and general features of this subject; the details are mostly printed in unavailable form, either in service journals or in confidential documents. References to some of the former can be furnished, if desired.)

12. REPORT OF NATIONAL COAST DEFENSE. (Taft) Board, 1906. May be obtained from Army War College, Washington, D. C. Free. (The official project for harbor defenses of the United States. On account of progressive obsolescence of seacoast defenses, this project has been, or is being, modified, but still sets forth clearly the fundamentals.)

13. LECTURES ON SEACOAST DEFENSE. Winslow. Publishers: United States Engineer School, Washington Barracks, D. C. Price 50c. (Much of these lectures relates to technical details, and a considerable part is now obsolete.)

14. PERMANENT FORTIFICATIONS. Fieberger, 1900; United States Military Academy, West Point, N. Y.; \$1. May be obtained from Book Dept. (While rather old, this work gives a simple presentation of the fundamentals on its subject, including an historical outline. A revised edition will soon be published.)

15. FORTIFICATIONS. C. S. Clarke. Dutton & Co., New York; \$4.50. May be obtained from Book Dept. (A treatise on the same lines as 14.)

16. PRINCIPLES OF LAND DEFENSE. Thuillier, 1902; Longmans, Green & Co. May be obtained from Book Dept.; \$3.83. (A valuable work, covering the principles of both field and permanent fortification.)

C. ORGANIZATION, EQUIPMENT AND DUTIES OF ENGINEER TROOPS

17. FIELD SERVICE REGULATIONS. 1914. (See A. 3.)

18. TABLES OF ORGANIZATION, 1914. May be obtained from Supt. of Docs.; 25c. (These tables represent—subject to modification and within the limits of existing law—the approved policy of the War Department with regard to organization.)

19. OFFICIAL BULLETIN, Office of the Chief of Staff, Vol. 1, No. 4 (Appendix 4. Use of Engineer Troops). Publisher: Army War College, Washington, D. C. Free. (An official statement of the principles which should govern in the use of engineers, with practical suggestions.)

(Continued on Page x)



ILLUMINATING ENGINEERING SOCIETY PHILADELPHIA SECTION

WALTON FORSTALL, Chairman

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AN exceedingly successful season for the Philadelphia Section of the Illuminating Engineering Society was brought to a close on May 18, 1917, when the final monthly section meeting was held at the Engineers' Club, 1317 Spruce Street.

As a preliminary to the meeting, there was the usual small but enthusiastic group at dinner, where many points of interest on the application of light and illumination to the successful conduct of the war were discussed. The General Society has already offered its services to the United States Government in this regard.

As a wind-up to the series of elementary talks on the fundamentals of illuminating engineering, Dr. H. E. Ives

brought out an interesting analogy between the production and flow of light and the storage and flow of water. A lumen of light flux was compared to a unit volume of water, so that the quantities and rates of an invisible radiation might be visualized by means of comparison with a well-known and common physically tangible entity.

The main paper of the evening was "Progress Notes—Incandescent Lamps and Lighting," by Unit Rasin, of the Westinghouse Lamp Company, and is given in full below.

A full and interesting discussion was provided by several members and guests.

PROGRESS NOTES

INCANDESCENT ELECTRIC LAMPS AND LIGHTING

By UNIT RASIN

IT is the purpose of this article to touch briefly on some of the more important developments in the use of incandescent electric lamps and to describe in a few words lamps which have been developed and placed on the market in the past year. The information given is necessarily rather brief, but it is hoped that it will be of interest and value to those who may be interested in lighting and its progress.

MAZDA C-2 (DAYLIGHT) LAMP

The Mazda C-2 lamp has been developed to meet the demand for a satisfactory, inexpensive illuminant-producing light of approximate average daylight quality.

For accurate color matching the light should be of the same quality as north sky light, but in many cases, such as in general illumination of a drygoods store or a printing establishment, light of the quality of average daylight, which is not quite so blue, is satisfactory.

Color-matching units using arc or incandescent lamps and filters of glass or gelatine for modifying the light to the desired quality have been available for some time, but these are essentially local lighting and are limited in their use to color-matching rooms and booths. For general illumination with lights of average daylight quality Mazda C lamps in enclosing globes of bluish glass have been used.

There was, however, a demand for a lamp which would produce light of average daylight quality without

the use of additional modifying devices, and efforts were therefore directed towards the production of a glass bulb for the Mazda C lamp which would in itself act as a filter for modifying the light to the desired color. The result of this research was the bluish bulb now used in the Mazda C-2 lamp.

This lamp may be used in direct, semi-indirect, or indirect lighting fixtures exactly as the clear Mazda C lamp is used, and will produce light which approximates average daylight very closely, providing the glassware or reflector used has not in itself color-modifying qualities, and, in the case of semi-indirect and indirect lighting, providing the ceiling and walls are white.

The Mazda C-2 lamp is particularly valuable for use in offices where the natural illumination is insufficient toward the end of the working day and it is necessary to use artificial light. Under such conditions the additional illumination produced by the Mazda C-2 lamp seems to blend with the daylight, and the observer is unconscious of the artificial lighting system, because the natural light and artificial light are of substantially the same color.

To produce the same illumination with Mazda C-2 lamps as with Mazda it is necessary to use about 35 per cent. more energy. If, for instance, 1 watt per square foot produces a certain illumination with Mazda C lamps, it will be necessary, in order to get the same illumination, to use about 1.35 watts per square foot with Mazda C-2

lamps. If, however, it is simply desired to substitute Mazda C-2 lamps for Mazda C lamps in an installation without changing the location of fixtures, etc., the lamps may be substituted on the following basis:

100 watt C-2 lamp for	75-watt C lamp
150 watt C-2 lamp for	100-watt C lamp
200 watt C-2 lamp for	150-watt C lamp
300 watt C-2 lamp for	200-watt C lamp
500 watt C-2 lamp for	400-watt C lamp

The blue bulb of the Mazda C-2 lamp is not designed for accurate color-matching work. The purpose was to develop a lamp which would produce a light of about the same quality as average daylight. Of course, daylight varies considerably with the time of day, the state of the atmosphere, and it is also very greatly influenced by surrounding buildings, etc. In general it may be said that average daylight is much less blue than people imagine, and is quite a bit less blue than the north sky light, which is used for accurate color matching. Therefore the light of the Mazda C-2 light produces a very close approximation to the color of the natural illumination as it is found in offices, stores, etc.

MAZDA C-3 LAMPS

The bulb of the C-3 lamp is made of an entirely different glass from that of the C-2 lamp. This glass absorbs more light than does the bulb of the C-2 lamp, and is, furthermore, so designed that, although the radiation in the visible spectrum is cut down materially, the actinic or chemical active radiation which affects the photographic plate is cut down but little.

The blue bulb of this lamp was made necessary by the fact that in photographic studios, in the making of portraits, etc., it is necessary to produce a very high illumination in order to get speed. With the unmodified light of the Mazda C lamp there is a possibility of glare with this high illumination. Efforts were therefore made to develop a bulb which would cut down the glare without, at the same time, reducing the photographic speed of the lamp. This result has been obtained in the Mazda C-3 bulb, and this lamp is therefore very satisfactory for portrait and motion-picture work.

Although incandescent filament lamps of the Mazda B or vacuum type had not been used very largely in photographic work because of the relatively low actinic of the light, it was found that the Mazda C lamp successfully met the requirements of this class of work.

Because this type of lamp can be operated from any lighting circuit, because there is no mechanism to get out of order, and because the light may be very efficiently controlled by means of reflectors, efforts were soon made to use the lamp in portraiture and other studio work.

After considerable experimental work to determine the requirements of a light-source for such work, the bulb of the Mazda C-3 or photographic lamp was developed. The bulb is of a special bluish glass which permits the actinic radiation from the filament to pass

with but little loss, but filters out the red, orange, and yellow rays in such proportion that the quality of the light is much the same as that of daylight.

Furthermore, the actinic value of the light is approximately the same as that of daylight, and the time of exposure for equal intensities of diffused daylight and the light of the Mazda C-3 lamp is therefore practically the same. This is of great value, particularly when the Mazda C-3 lamp is used to supplement daylight on cloudy days or late in the afternoon.

LAMPS IN AMBER BULBS

The constant increase in the efficiency and the corresponding increase in the intrinsic brilliancy of Mazda lamps have largely been responsible for introduction of the indirect and semi-indirect fixtures in which the light-source itself is concealed. Although such units serve their purpose admirably, there are many to whom the relatively white light of the Mazda lamp has seemed to be unsuited for the best decorative effect for home use, unless modifying devices, such as shades of colored materials, are used. The desire seems to be for light which is somewhat warmer than the light of the Mazda lamp, and this subject is now being investigated with a view to determining whether a quality of light which will be satisfactory in most cases can be obtained by the use of amber or other yellowish bulbs.

By means of such bulbs it is possible to simulate the color of the kerosene flame, the color of the old carbon filament lamp, or the color of the metalized filament lamp which was largely used by the Central Station Companies for a free renewal lamp a few years ago.

It is probable, however, that no definite line of lamps will be produced with these characteristics until the various committees of electrical societies, including the National Electric Light Association, have agreed on some color or colors which will be most suitable.

FLOOD LIGHTING

What was probably the first important example of flood lighting was the illumination of the tower of the Singer Building in New York City in 1909 by arc searchlights. The use of this form of lighting then spread slowly until the opening of the Panama Pacific Exposition, where flood lighting was very widely used in the production of some of the most beautiful lighting effects. Since the exposition the application of this method of lighting has spread with great rapidity, until at present there is hardly a city or town in the country without its flood-lighted monument or public building.

The very rapid progress in the use of flood lighting has been due to the development of very efficient concentrated filament Mazda C lamps, which provide a very much more satisfactory light-source than the arc lamp. The principal difficulty experienced in flood lighting by means of arc searchlights is the necessity of continually adjusting the lamp. With the use of incandescent lamps in the newer types of flood-lighting projectors this diffi-

culty has been overcome, and flood-lighting units using Mazda C lamps do not require any attention whatever except for occasional cleaning and replacing burned-out lamps.

While flood-lighting units are of great advantage and possess a great degree of usefulness in the illumination of buildings and monuments at night, they are also very useful for other purposes. This method of lighting has been used for outdoor theatrical performances, pageants at night, and also for lighting tennis courts, snow slides, skating ponds, and bathing beaches. Another field which from the commercial standpoint is very important is the illumination of signs and other advertising devices, particularly when these are in rather inaccessible places. By means of flood-lighting units placed at a distance they may now be lighted at a very small initial expense and for very moderate maintenance cost, considering the value of the advertising obtained.

A recent and very important use of flood lighting is for the illumination after dark of the vicinity of factories engaged in making war materials, of railroad yards and wharves, and of bridges and other points of military importance which must be protected against intruders. Under the circumstances it is essential that the lighting be adequate and so arranged that the units are protected against injuries which might cause the failure of the system at a critical moment. Flood lighting, therefore, is usually to be preferred to lighting by means of local units which may be tampered with, since the flood-lighting projectors may be mounted at a considerable distance from the area to be illuminated and adequately protected from injury. Although much of the flood lighting now done in industrial plants has been made necessary by the state of war in which the country now finds itself, it is inevitable that the impetus given to the use of this system of illumination will result in opening up many new fields, the illumination requirements of which will be successfully met by the use of flood-lighting units.

STEREOPTICON LAMPS

Within the past year many small portable motion-picture and lantern-slide projection outfits have been placed on the market. Some of these equipments are designed for home use, but others are designed primarily for the use of salesmen, who can now show a prospective customer motion pictures of the actual operation of a large machine, such as a steam shovel or tractor. These portable equipments are also very useful to lecturers who have been hitherto restricted by the necessity of using cumbersome and inefficient projection devices in their work. The lamps used are of the Mazda C stereopticon type, with very closely concentrated filaments, and may be operated from the ordinary lighting circuits.

TRAIN LIGHTING LAMPS

The use of the incandescent electric lamp for the illumination of railway cars has progressed to such a point that such lighting may be considered standard practice in so far as new cars are concerned. The advantages of

such lighting over lighting by means of oil or gas lamps are so great that many railroads have not only standardized this system for new cars but are changing over the equipments of old cars as rapidly as possible.

The traveling public now demands better lighting in railway cars, and to meet the requirements of the railway engineers many sizes of Mazda lamps have been designed for such service. The most recent addition to the lamps available for this purpose is the Mazda C lamps rated at 40, 75, and 100 nominal watts. These lamps will make it possible to obtain better illumination than has been attained in the past, since the light output per watt is greater with these lamps than with the Mazda B lamps, and it will therefore be possible to obtain more light for the same energy. This is of great importance, because the size of generating equipments is necessarily restricted by conditions that obtain in this service.

HEADLIGHT LAMPS

A great deal of attention has recently been devoted to the subject of providing satisfactory headlights for railway trains. This has resulted in the development of very efficient incandescent lamps designed especially for such service. Experiments made on various types of headlights have proved that headlights using incandescent lamps of the Mazda C or gas-filled type, with very closely concentrated filaments, are more efficient and economical than those employing oil or acetylene flames. The closely concentrated filament makes it possible to design reflectors which control the light much more efficiently than could be done with a more extended light-source—the oil flame, for instance. Furthermore, since it is not necessary to cut away part of the reflector, as must be done with any flame-source, more of the light from the lamp is picked up by the projector.

150-WATT MAZDA C LAMP

Owing to the growing demand for a 150-watt Mazda C lamp for use on circuits of 110 to 125 volts, a lamp of this size has recently been placed on the market. The lamp is made in the PS-25 bulb, which is the same size as that of the present 100-watt Mazda C lamp, and it may therefore be used in fixtures designed for the 100-watt lamp.

A lamp of this size should prove particularly useful in those cases sometimes encountered in designing lighting installations where the present 100-watt lamps do not provide enough light and the 200-watt lamps provide somewhat too much. Furthermore, it will produce approximately 25 per cent. more light of better quality than the 150-watt Mazda B lamp, which is now practically obsolete.

LAMPS FOR COUNTRY HOME LIGHTING

During the past year many manufacturers have placed on the market small lighting equipments for farm and country home lighting, and in order to meet the demand of this new field a number of lamps designed particularly for this service have been standardized. In most cases

the equipment consists of a gasoline or kerosene motor, a generator, a switchboard, and a number of storage cells, usually sixteen in number. The lamps have therefore been designed to operate on sixteen cells of lead plate type storage battery, and include the following: 5, 10, 20, and 40-watt Mazda lamps and 50, 75, and 100-watt Mazda C lamps.

The isolated farm or country dwelling may now enjoy the advantages of the electric light and power and also make use of flatirons, vacuum sweepers, etc., which have also been designed especially for operation from this type of lighting plant.

VOLTAGE STANDARDIZATION

In the early days of incandescent lamp manufacture, when the carbon filament lamp was the standard lamp, it was found very difficult to manufacture lamps to produce a certain candle-power at a certain voltage. As a result the voltage range was from 100 to 130 volts, and the various central stations accommodated themselves to this condition by adopting voltages within this range.

With the Mazda lamp, however, filament manufacture has been brought to such a degree of perfection that it is now possible to manufacture lamps to operate at any predetermined voltage, and a wide voltage range is no longer necessary.

Some central stations have continued to operate at the voltage standardized on when carbon filament lamps were used, and it has been necessary to manufacture lamps for all voltages between 100 and 130 volts. On the other hand, many central stations formerly operating at 100 to 109 volts have standardized on 110 volts, and at present the greater number of central stations supply energy between 110 and 125 volts.

An investigation showed that in the year 1916 about 60 per cent. of all the lamps used in the United States were rated at 110, 115, or 120 volts, and the greater number of the remainder were rated between 112 and 125 volts.

It would therefore seem that the attainment of three or four standard voltages—for instance, 110, 115, and 120 volts—would be entirely practicable. This would result in a very much more satisfactory condition than now exists, not only to lamps, but also as to motors, heating devices, flatirons, and, in fact, all electrical devices, because it would not then be necessary to manufacture such devices for operation at the various voltages between 100 and 130 volts.

This matter of standardizing voltages is now being given very serious consideration, and it is very probable that steps will be taken by the electrical industry to standardize on 110, 115, and 120 volts.

LIGHTING CODES AND LIGHTING LEGISLATION

For several years lighting engineers and others interested in the problem of illumination have realized the unsatisfactory lighting in the majority of industrial plants throughout the country. The Illuminating Engineering Society took up the matter and committees were appointed to investigate existing rules on the subject of lighting, to study the actual requirements for proper lighting, and, finally, to draw up a code which would show what the actual requirements were and how they should be met. Up to this time practically no legislation was in force regarding proper lighting, and what little there was showed lack of knowledge of conditions and ability to cope with the situation.

Investigations showed that little or no attention was paid to the protection of the eyes of the workers, and also that the lighting of the aisles and spaces where actual work was not taking place was greatly neglected. In general it was found that little effort was made to direct light on the work by means of proper reflectors, and that in many cases the illumination was too low.

The code drawn up by the Illuminating Engineering Society provides for all of these items for all classes of work, and is accompanied by photographs and cuts showing good and bad practice.

The matter has been laid before the legislative bodies of several states, with the result that Pennsylvania and New Jersey have adopted codes very similar to this code, and steps are being taken by other states to enact similar laws at an early date.

The codes adopted by the two states mentioned provide for a minimum intensity of illumination on the work, the use of suitable reflectors, and emergency lighting systems for use when the regular lighting fails.

Codes on school lighting, street lighting, and automobile and railway headlighting are in the course of construction and are expected to be ready for publication at an early date. It is also hoped that eventually all the states of the Union will adopt the same general code and thus standardize the lighting requirements in the United States.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS .: PHILADELPHIA SECTION

NATHAN HAYWARD, Chairman

H. MOURADIAN, Secretary, 1631 Arch Street

RESULTS OF ANNUAL ELECTION

AT the annual dinner held at the Engineers' Club, Monday evening, June 11, 1917, Chairman H. P. Liversidge announced the results of the annual election and declared the following officers elected for the 1917-1918 season, beginning August 1, 1917:

Chairman (elected to serve one year)—Nathan Hayward.

Secretary and Treasurer (elected to serve one year)—H. Mouradian.

Assistant Secretary (elected to serve one year)—E. B. Tuttle.

Managers (elected to serve two years)—M. G. Kennedy, H. Goodwin, Jr., W. F. James.

The following managers, elected in 1916, continue to serve during the 1917-1918 season:

St. John Chilton

L. J. Costa

Benj. P. Foster

Following the announcement of the results of the election, Chairman-elect Nathan Hayward addressed the

meeting. A rising vote of thanks and appreciation was extended to the retiring officers.

THE ANNUAL DINNER

The judgment of the Board of Managers that the annual dinner should properly be of a quiet and informal nature was proved sound when about forty members met at the Engineers' Club, Monday evening, June 11, 1917, and after dinner listened to short talks by members and guests who are engaged in various classes of war service for the government. The principal object of the dinner was to throw some light on a subject which is now uppermost in the minds of all engineers; namely, "How must I go about determining my particular duty toward my country in the present emergency?" The serious consideration which is being given this matter by all was evidenced in the close attention with which the remarks of the speakers were received.

The speakers were: Dr. Geo. S. Crampton, Mr. W. C. L. Eglin, Mr. J. F. Stevens, Mr. Paul Spencer, Lieutenant Josephs, U. S. R. C., and Mr. J. H. Tracy.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS EASTERN PENNSYLVANIA CHAPTER

GEORGE W. BARR, President

GEORGE BOON, Secretary

THE summer meeting of the American Society of Heating and Ventilating Engineers will be held in Chicago, July 18, 19, and 20. This notice is given for the reason that several members of this Chapter were under the impression that this meeting had been cancelled; also with the hope that this Chapter will be well represented.

Among the many subjects of national importance to be considered at this meeting is the present state of the art of drying fruits and vegetables. Air conditioning in its broadest sense is now recognized as a subject of growing importance that must be properly cared for by the heating and ventilating engineer.

It is gratifying to learn that the combined efforts of the medical profession and the Red Cross Society have resulted in the special instructions on ventilation now being given to men in training and those in charge at permanent and temporary training camps. Under the general subject "Hygiene," proper ventila-

tion is insisted upon as the greatest preventative of disease and contamination.

On account of the general shortage of fuel this past winter, a great quantity of bituminous coal has been used in apparatus designed for anthracite. The various results have emphasized the importance of the subject of smoke abatement. This subject is now the topic for discussion and investigation of several Chapters. The problem is not smoke consumption, but—smoke prevention; in other words—better combustion. This Chapter is requested to consider the subject, not only from the standpoint of the theoretical value of the many different grades of bituminous coal, but the necessary requirements in design of apparatus sufficiently pliable for the use of all grades, and comply with requirements of the many city ordinances regulating the use of bituminous coal.

The next regular meeting of this Chapter will be held October 11.



TECHNOLOGY CLUB OF PHILADELPHIA

H. A. TERRELL, President.

G. W. BARNWELL, Secretary,
33 Cooper St. Camden, N. J.



ANNUAL FIELD DAY

THE annual Technology Field Day was held Saturday, June 2, 1917, at Woodbury Country Club, and proved to be one of the best ever held, favorable weather conditions helping to swell the attendance to seventy-five or more. Several new features were introduced. Heretofore, the opposing teams were composed of the married and single men. For some unknown reason the married men suggested a toss-up-and-choose division, so this year the teams were known as the "Reds" and the "Greys," each containing its quota of bachelors and bachelorettes. Red and gray badges were worn to prevent any "ringers."

The contests consisted of a five-inning baseball game, which went to the Reds by a score of 12 to 3; a sack race won by the Greys; a centipede race won by the Greys; a shoe race won by the Reds; two relay races, one going to each team; a tug-of-war in which the Greys pulled the Reds off their feet, and a mystery (which proved to be a leap-frog) race which the Reds won easily.

The points as scored were as follows. Each event was allowed 100 points.

	Reds	Greys
Baseball game	100	0
Sack race	25	75
Tug-of-war	0	100
Centipede race	25	75
Shoe race	100	0
Leap-frog race	100	0
Relay race (with glass of punch).....	0	100
Relay race (with 12-foot pole).....	100	0
Totals	450	350

So the final results showed the Reds winners by 450 points to 350, and, as it was agreed beforehand that the losers should serve the eats, it was no "empty" victory. In the evening an hour was devoted to the singing of Tech. songs and national airs, and dancing topped off the festivities.

MEETINGS

At this time no meetings are scheduled for the summer months, so our first regular meeting will be in September, but it is quite possible that another outing will be had by the Club some time during the hot-weather months. Post-card announcements will be mailed.

TECHNOLOGY CLUB AND UNCLE SAM

The Club is trying to do its share towards mobilization by contributing \$200 to the Technology fund which is being raised to maintain headquarters in Washington to coöperate more closely with the government in dealing with Technology men. Also, several of the members of the Club have gone into active service or are lining themselves up. P. E. Tillson, of the Bell Telephone Company, is now a lieutenant in the navy. F. B. Barnes writes from Seattle, Wash., that he is on his way to California to report for duty. G. W. Barnwell expects to report to the second officers' camp in August, and others whose exact movements are not known to the writer are preparing themselves for active service.

MILITARY BOOKS FOR ENGINEERS (Continued from page x)

contemplated, but will not be ready within a year. The portion of the manual relating to field fortification, being somewhat obsolete, should be considered in connection with either 30 or 31 above. The portion relating to railroads is largely superseded by 35 below.

33. NOTES ON BRIDGES AND BRIDGING. Spalding. May be obtained from Book Dept. (A small pamphlet on military bridging.)

34. MILITARY TOPOGRAPHY FOR MOBILE FORCES. Sherrill, 2d edition; Banta Publishing Co., Menasha, Wis., 1911. May be obtained from Book Dept.; \$2.25. (Besides matter given in ordinary textbooks on surveying, this work gives in detail the special methods of sketching developed in the army for rapid military mapping.)

35. MILITARY RAILROADS. Connor; Professional Paper No. 32, Corps of Engineers, United States Army. Supt. of Docs.; 50c. (Intended to cover general administration of existing railroads for military purposes and the handling of railroads by military personnel in the advance sections where railroads cannot be operated by their regular civilian organi-

zations, or where new railroads are required in the immediate vicinity of the army. Revised edition soon to appear.)

36. NOTES ON MILITARY EXPLOSIVES. Weaver; J. Wiley & Sons, New York, 1912. May be obtained from Book Dept.; \$3.25. (Elementary notes on this subject will be found in the Engineer Field Manual and other references cited. This work is more elaborate.)

E. MISCELLANEOUS

37. REGULATIONS FOR THE ARMY OF THE UNITED STATES. Supt. of Docs.; 50c.

38. THE VOLUNTEER LAW, approved April 25, 1914; Bulletin No. 17. War Department, 1914. May be obtained from The Adjutant General, United States Army, Washington, D. C. Free.

39. GENERAL ORDERS NO. 54, War Department, 1914. May be obtained from The Adjutant General, United States Army, Washington, D. C. Free. (Covers examination of candidates for commissions as officers of volunteers.)

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CONTENTS OF THIS ISSUE

	PAGE		PAGE
Japan and America in the World War.....	351	Editorial.....	379
By DR. TOYOKICHI IYENAGA			
Philadelphia Bridges—Past, Present, and Future..	354	Committee on Papers.....	380
By WILMER Z. KLINE		LEWIS H. KENNEY, Chairman	
Layout of Machine Tools for a Large Light Manu- facturing Plant.....	362	Committee on Membership.....	381
By DAVID J. MATLACK		D. ROBERT YARNALL, Chairman	
Code of Lighting—Factories, Mills and Other Work Places	364	Committee on Coöperation for National Defense... 382	
By Courtesy of the ILLUMINATING ENGINEERING SOCIETY		GEORGE R. HENDERSON, Chairman	
Some Random Observations on the Relation of the Junior Member to the Engineers' Club.....	377	American Society of Mechanical Engineers.....	383
By S. M. SWAAB		The American Uniform Boiler-Law Society	383
Officers, Directors, Standing and Special Commit- tees of Engineers' Club.....	378	A Few Facts Relative to the Geology of Philadelphia	386
		Committee Report—Junior Section.....	388
		Regulations for the Aviation Section of the Signal Officers' Reserve Corps.....	389

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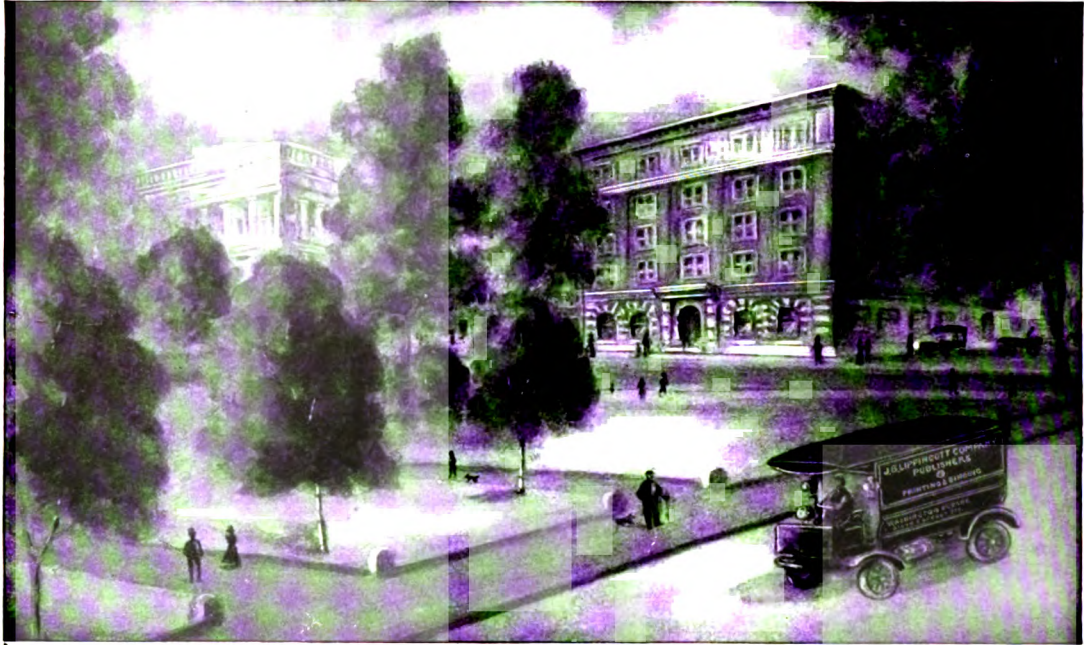
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MONTREAL

LONDON

JAPAN AND AMERICA IN THE WORLD WAR*

DR. TOYOKICHI IYENAGA

MANAGING DIRECTOR OF THE EAST AND WEST NEWS BUREAU

IT need hardly be emphasized that Japan, as one of the Entente Powers, hails with great joy the entrance of America into their ranks to wage war against a common foe. There also is a special reason for this, for there are striking resemblances between the two countries in their geographical positions and in the attitudes they assume toward the European war. Unprecedented prosperity has come to both, and now that they have joined hands as belligerents, the chief functions they should fulfill are not dissimilar, namely, patrolling the seas and supplying their allies with arms, munitions, food, and money. The position of the United States and her possessions, together with her vast, splendid naval resources, impose upon her the duty of helping her allies to destroy the menace of the pirates that infest the high-roads of commerce and the communication of the world.

President Wilson has most lucidly stated the reasons the United States entered the war, and his message has been greeted in Japan with profound admiration and whole-hearted satisfaction. He showed that we are making this war to crush German militarism—not the German people—so that an endurable peace, based on justice, equality, and liberty, may be secured. Consequently, America and Japan will join hands in every move made at the Peace Conference which will end the war, and will exert their influence together. Such coöperation, to quote the words of the Japanese Emperor in his congratulatory message to President Wilson, will serve to “cement and consecrate the lasting friendship between our two nations.”

The world war, raging for the last two years and nine months with violence unheard of, unrecorded in history, has reached its final stage. The final decision cannot be long deferred, for otherwise the civilized world will be plunged into a catastrophe the magnitude of which is difficult for the imagination to grasp.

There was a time when doubt might have been entertained whether the European war would not end in a draw—in “peace without victory,” as your President expressed it. When the policy and war measures adopted by the Entente Powers in the Balkans showed unmistakable signs of weakness, indecision, and lack of cohesion, the Allies being completely out-manuevered and out-fought in the vigorous and well-managed campaign of the Central Powers, too much optimism for the decided triumph of the Allied cause seemed unwarranted.

* Presented at Meeting of Engineers' Club, May 4, 1917.

The first intimation that this temple of success reared by German arms could not long endure, but must sooner or later crumble to the ground, came through the publication of the now notorious Zimmerman note proposing a German-Japanese-Mexican alliance to counteract the hostile measures of America. The monstrosity of that note was only equalled by its stupidity. For Japan, my friends, it can most emphatically be said that the note is a sufficient warrant to judge how utterly ignorant the plotters were of Japan's history and aspirations. It completely ignores the spirit of Japan, which puts honor and loyalty foremost in the list of virtues. A nation which holds honor dear to its heart will never, I can assure you, turn traitor to its allies, nor without cause assail another nation with which it is on friendly terms.

Germany has doubtless measured Japan with her own standard of international ethics. Let me illustrate what I mean. Following the conclusion of the Shimonoeki Treaty, when Germany, Russia, and France formed an unholy alliance for the express purpose of robbing Japan of the best fruits of her victory over China, by forcing upon her the retrocession of the Liaotung Peninsula, Count Ito, then Premier of Japan, exclaimed, “Germany we shall never forgive.” Russia looks upon us as a future rival in the Far East. France is, of course, her ally and has important possessions and ancient interests in Eastern Asia. We can understand their action; but for Germany, who always professed friendship, to join hands with them and stab us in the back made her intervention odious and gratuitous.

In the same manner Germany thought that Japan might be induced to play her foul game against the United States in the event of war between the two powers. Manifestly, German statesmanship was well-nigh bankrupt when it hatched such a preposterous plot. Her greatest mistake, however, was her failure to prevent the entrance of the United States into the war. When the President and Congress of the United States resolved that this country should enter the war, the death-knell of German militarism was sounded. It is beyond my comprehension how Germany could challenge the United States to swell the ranks of her enemies! Have the souls of Kant, Goethe, and Bismarck fled from the Fatherland, in condemnation of the horrible crimes the Germans are to-day perpetrating on alien soils and high seas? It was sheer madness for Germany to rouse the sleeping giant on this

hemisphere and to let him mobilize the tremendous resources at his command in man-power, money, munitions, and what not. There is now no room for doubt whatever as to which side will be the final victor. The only question, therefore, that remains is, How long will it be before Germany collapses? It is not too bold to say that it will be to the best advantage of Germany to sue for peace to-day, and to stop the awful carnage and destruction. If Germany to-day asked her enemies for lenient terms, I presume they would not be loath to grant them. In this respect the influence of the United States at the Peace Conference would doubtless be exerted strongly in favor of Germany. Were Germany so to act, I could understand for the first time why she dragged the United States into the war.

The period of the war depends upon two things: the result of the submarine warfare and the decisive blow dealt by Germany on Russia. It can hardly be expected an ally of Russia should say anything discouraging to her outlook, but that the situation there is far from reassuring is shown by the fact that America is sending her Commission to the European Allies—first of all to Russia.

As to the submarine warfare, menacing as it is, the allies will find a way to combat it. Just as it is wrong to minimize the result of that warfare, so is it wrong to overestimate the ravages of the submarine. While the Allies heretofore have been minimizing the danger, now they are overrating it. We need not be so enslaved by the god of the U-boats as to be blind to the fact that his frightfulness from now on will be fully matched by American inventiveness and resourcefulness, and many times more tonnage than he can destroy will be forthcoming from the all-embracing lap of the American giant.

Turning now to the relations between Japan and America, let us first survey the past history of these relations. In the history of international relations, no record is so unique as the intercourse between America and Japan during the first five decades of its existence. Strikingly dramatic is the scene that introduces the first chapter of that intercourse. To a nation still wrapped in a torpor of centuries Commodore Perry makes his sudden advent in 1853, with a stately fleet of eight ships, armed with 230 cannon. And, contrary to the expectation of the world, that sailor-diplomat succeeded in forcing open the gates of a nation which had for two centuries and a half been hermetically sealed against aliens, and without a shot being fired, a man wounded, or a junk sunk. His was truly a peaceful mission. Behind that outward display of force was hidden the genuine spirit of America's friendship toward Japan, which Commodore Perry had been commissioned to disclose. Japan was not slow to discover that spirit, and has always been grateful for it. In commemoration there stands to-day a monument on the very spot of Perry's first landing, backed by

the everlasting green hills of the Mikado's land and overlooking the blue waters of the Pacific. That monument binds the two great nations in everlasting friendship.

But the genuine Americanism found its finest expression in Perry's successor, Townsend Harris. With that simplicity and honesty worthy of a true American, Harris succeeded in overcoming the obstacles which suspicion and ignorance had put in his way, and finally signalized his triumph by becoming the adviser of the Shogun's Government. The policy of justice and square deal thus inaugurated was consistently pursued by all the succeeding administrations of the United States, and put into force by able envoys who represented the President of the United States at the Court of the Mikado. The refunding of the Shimonoseki indemnity of \$783,000 to Japan; the revision of old treaties which had denied to Japan the exercise of her judicial and tariff autonomy; the good offices rendered by ex-President Roosevelt in bringing the Russo-Japanese war to a successful conclusion; and the commercial treaty negotiated under the Taft administration, which facilitated the making of similar treaties with other Powers, are but a few instances of Japanese-American intercourse. In these we have witnessed the realization of what General Grant said: "Whatever American influence may have been in Japan, I am proud to think that it has always been exerted in behalf of justice and kindness." I am proud to say Japan has never been slow to appreciate your goodness and reciprocate your friendliness. In fact, the sentiment of gratitude toward America pervades the entire nation; it is not restricted or limited to a few circles. To be an American is to command the respect and love of the Japanese people. Let me repeat, then, that no record in international history has been more beautiful, more noble, than that which has marked the intercourse between your country and mine for the first five decades of that history.

The dawn of the twentieth century, however, brought a sudden turn to this happy history. The attitude of the United States toward Japan underwent a sudden change. From that of a godfather toward his foster-child, the United States began to look upon Japan as a future rival and possibly an enemy. Now, my friends, this was due partly to natural causes, but largely to the work of mischief-makers. Let us consider how this change was brought about.

Toward the close of the nineteenth century the Japanese nation, whom you had introduced into the family of nations, had, by dint of perseverance and energy, reconstructed its whole scheme of life—political, economic, social—and brought it to the standard of the West. In short, Japan had already attained her maturity, provided with almost every qualification that entitled her to rank among the first Powers. But, alas! that enviable position could hardly be secured by the pure logic of peaceful progress. Sad to say,

what prestige Japan gained was through two successful wars she waged against her two great neighbors. Thus the pigmy of yesterday was suddenly transformed, as mirrored in the eyes of Western nations, into the giant of to-day, and out of a frenzied imagination there sprang up a strange monster, called "the yellow peril," endowed with a magic power to carry fire and destruction into the heart of Christendom.

Now, this nightmare of "the yellow peril," created by the fertile brain of the Kaiser, swept across the Atlantic and came to have its lodging even in the hearts of the Yankees. This idea of "yellow peril" was most skillfully utilized by the "yellow press" of this country, which began to carry on its own propaganda, to promote its own selfish interests. Hereafter you will see that Japan was utilized whenever you wanted appropriations for a big navy and a big army because there was no other Power which could be utilized for that end. You were at peace with Germany, with Russia, with Great Britain. You were most affectionately attached to France, and where was the enemy that you had to provide against with big guns? So Japan was every time utilized for the purpose.

But, with all this, jingoists and yellow journals would not have been able to arouse American feeling had there not been important national questions connected therewith. Those questions are: First, the Japanese-California controversy; second, the Monroe Doctrine and Japan; and, third, the policy of your country and Japan toward China.

The Japanese-California question is no cause for war between your country and mine. The Monroe Doctrine only acts as a brake to prevent the clash of interests between America and Japan. The Pacific is broad enough to accommodate, without jostling, all the navies and fleets of both nations. Those who have not seen the vast expanse of the Pacific are the people who fall victims to that claptrap called "mastery of the Pacific."

The course of America and Japan in China runs in parallel, not conflicting, lines, with only this difference: that Japan has a most vital political interest in China, while America has not. China's weakness constitutes a constant menace to Japan's national exist-

ence. Japan is therefore jealously eager of China's regeneration. What causes are there, then, that would warrant the heinous outcry that there is danger of conflict between America and Japan? None whatever! On the contrary, there are solid, substantial grounds that call loudly for the maintenance of their traditional friendship. The country that imports most from Japan is the United States of America. You buy raw silk alone amounting to one hundred million dollars per year. Were you to stop buying Japan's staple products—silk, tea, and art objects—Japan's economic life would be immediately paralyzed. Nevertheless, Japan's friendship toward America does not come from these sordid motives, but from love of American ideals. Nor does Japan's respect for America spring from the array of millions of soldiers and mountains of gold and treasure that America has or can provide. Japan's admiration and regard for America has its foundation in her deep conviction that American greatness rests upon her sense of justice, her fairness, and her humanity.

In concluding, there is one more point to which your attention is invited. For the furtherance of the cause of harmony between America and Japan, my friends, nothing is more important than to eradicate the root of trouble that lies between the two countries. The task is not difficult if you have the will to do it. It must be definitely understood that Japan does not want to force upon the American people unrestricted immigration of her subjects. What she asks is simply just and fair treatment to a small number of Japanese subjects residing in this country—perhaps 80,000. In other words, the full recognition of their equality with the people of other nationalities. Do not misunderstand that I am insisting upon the repeal of the Anti-alien Land Law of California. I am simply advocating that the same principles of justice, equality, and liberty, for whose maintenance in the world you have not hesitated even to run the hazard of this mighty war, should be put into effect in the relations between America and Japan as in all international relations. There may be many ways to accomplish the purpose. American resourcefulness, which is unbounded, is certainly equal to the test.



PHILADELPHIA BRIDGES*

PAST, PRESENT, AND FUTURE

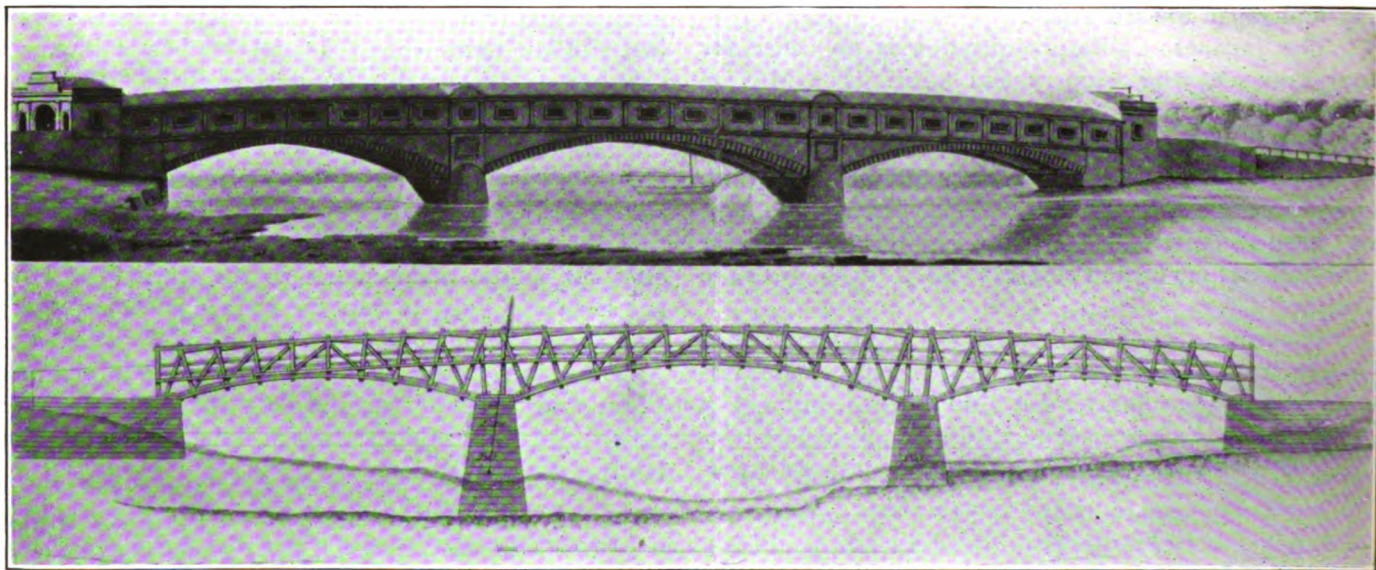
BY WILMER Z. KLINE

BUREAU OF SURVEYS, PHILADELPHIA

IN considering Philadelphia bridges of the past, it is necessary to go back to the beginning of Philadelphia itself. Available information concerning these very old bridges, however, is very inaccurate and incomplete. Beginning with 1682, bridges were constructed from time to time over Dock Creek, Pegg's Run, Gunner's Run, and other creeks. Mulberry Street gradually acquired its present name of Arch Street from the fact that Front Street crossed over it by means of an arch. Some of these old bridges were of timber, some of brick, and some of stone. Beyond these few facts, however, we know practically nothing. The most noted of all these very old bridges was Poole's Bridge. It carried Front Street over Pegg's Run at what is now Front and Willow Streets. This bridge was of masonry, and was of such proportions that no Philadelphian could be found capable of building it. Baltimore furnished the masons. Beginning with the Revolution, our data on bridges became more definite and complete. This is perhaps due to the

known as the Middle Ferry; another one at Callowhill Street was known as the Upper Ferry; and the existing bridges at Gray's Ferry and Penrose Ferry take their names from ferries that had existed at those points. In 1776 General Putnam constructed a floating bridge at the Middle Ferry as a military necessity. The British also built a floating bridge at this point during their occupation of Philadelphia. When the American army returned to Philadelphia, the latter bridge was moved to Gray's Ferry and the old American bridge replaced. These bridges played a prominent part in American history, as they were both used by the Continental Army on its way to Yorktown. In 1789 Washington passed over the Gray's Ferry Bridge on his way to New York to assume the Presidency. The bridge was arched over and highly decorated for this event, and special ceremonies were held at the bridge.

The public desire for a permanent bridge over the Schuylkill was evident as early as 1751, when a com-



SCHUYLKILL PERMANENT BRIDGE
(Market Street over Schuylkill River)

fact that the problem of bridging the Schuylkill River was pressing for solution, and the resulting bridges occupied prominent places among the bridges of the world.

Prior to the Revolution, crossings of the Schuylkill were made by means of established ferries at certain points. One at High or Market Street was

* Junior Prize Paper, presented at Regular Meeting of Engineers' Club, June 19, 1917.

mission was appointed to consider the project. In 1769 a model for a timber arch was made by a Robert Smith. When the floating bridges were swept away in 1780, and again in 1784, demands for such a bridge were increased. Thomas Paine, the writer, then came forward with a plan to construct a cast-iron arch at Market Street. This arch was a single span of three hundred or four hundred feet, with a twenty-foot rise. A wood model was exhibited in Philadelphia and

PHILADELPHIA BRIDGES

Paris with success. Two ninety-foot cast-iron ribs ordered in England were tested with double their own weight with satisfaction. Meanwhile a company was formed in Philadelphia with a capital of \$66,666.66, but, the proper financial backing not being obtained, the project was dropped.

A company formed in 1798 had better results. This company purchased the Middle Ferry rights at Market Street. A design for a wooden bridge was prepared by Timothy Palmer, the noted bridge builder of that time. From this design the Schuylkill Permanent Bridge was constructed, between 1801 and 1804, at a cost of \$300,000. The central span is 195 feet clear, and the two side spans 150 feet clear. There are three lines of trusses, which are said to be white pine. A stone monument was placed on one approach, giving full details of the bridge. This monument is now at Twenty-third and Market Streets. Historians tell us that Philadelphians were so proud of this bridge that, in 1806, five thousand people made their way over ice and snow on a cold winter night to protect the bridge from a fire close by. Passenger tolls were collected until 1840, when the city purchased the bridge. In 1850 it was remodelled to carry Pennsylvania Railroad tracks. In 1875 a gas main explosion on the bridge started a fire which completely destroyed the structure. The Pennsylvania Railroad then constructed a wooden bridge in two hundred and seven working hours.

In 1884 bids were received by the city for a five-span masonry arch bridge at this location of a width of 100 feet. The low bid was \$1,000,000, but, as Councils would appropriate only \$275,000, this design was abandoned in favor of the present wrought-iron cantilever structure. This bridge, constructed in 1886, cost \$268,000. The piers were built on the foundations of the Schuylkill Permanent Bridge. The width is 77 feet; the centre span is 215 feet, and it contains a 76-foot suspended span. The side spans are each 98 feet. The railing contains relief panels of Penn, Washington, Putnam, and Judge Peters, the president of the Schuylkill Permanent Bridge Company. The use of a cantilever for this bridge was criticized, but was defended on the ground that definite street grades, clearances, and span lengths had to be maintained and that a cantilever bridge was most suitable for that reason.

At Fairmount, the site of the Upper Ferry and of the existing Callowhill Street Bridge, we find more interesting history in bridge construction. As in the case of Market Street, a floating bridge was maintained at this point prior to the building of a permanent bridge. In 1810 a company was chartered, and two years later work was begun from designs made by Louis Wernwag, a contemporary of Timothy Palmer. The Colossus Bridge can truly be termed a marvellous engineering feat in that time. The span was 340 feet, 98 feet longer than any other then known span. Wernwag

should command the respect of the engineers of to-day, not only for excellent engineering judgment when stress analyses were unknown, but also for the grace and beauty of this structure. Upon the day when the wedges between the structure and the false work were to be released thousands came out to the river to watch the bridge fall when the wedges were knocked out and the structure left to support itself. But Wernwag had loosened the wedges the day before, and while the people were watching for the great moment to come they were really looking at the bridge in a self-sustaining position. It is also interesting to note that Wernwag wanted to increase the span to 400 feet to secure better foundations, but the managers did not care to build such a notable bridge. That the structure was in no sense weak was proved shortly after its erection, when a twenty-two-ton block of marble was hauled over the bridge by sixteen horses.



UPPER FERRY OR COLOSSUS BRIDGE OVER SCHUYLKILL RIVER
(Callowhill Street)

In 1838 the Colossus was destroyed by fire of supposed incendiary origin. It was replaced by the city in 1841 by Colonel Ellet's wire suspension bridge. This bridge had a span of about 340 feet and was 25 feet wide.

In 1874-5, during the strenuous preparations for the Centennial, Ellet's bridge was replaced by the existing Callowhill Street Bridge. This bridge is really a double bridge, the lower deck carrying Callowhill Street and the upper deck Spring Garden Street over the Schuylkill River. The span is 348 feet.

At the Falls of the Schuylkill the first bridge was constructed in 1809—a chain suspension bridge of two 153-foot spans. It was built after the methods of James Finley, an authority on that kind of construction. In 1811 a crowding herd of cattle caused its collapse. Replaced the same year, it collapsed again in 1816 under a load of snow and ice.

White and Hazard, wire manufacturers of the neighborhood, then constructed a bridge, perhaps the most interesting of all Philadelphia bridges—a wire suspension bridge, the cables consisting of six three-eighth-inch wires. Its width was 18 inches, the cost \$125, and its capacity eight people at one time, although it is said it once supported thirty people. A toll of one cent was collected by its makers. It has the distinction of being the first wire suspension bridge in the world, and also of having the longest span of any other Philadelphia bridge—408 feet. One end of

the bridge was fastened to the wire factory, and to get on the bridge it was necessary to climb out a second-story window of the factory. The other end was fastened to a large tree, and the ground was reached from that end by steps. This bridge shared the fate of its predecessor and collapsed in less than a year from a load of snow and ice.

In 1817 a wooden bridge designed by Louis Wernwag was constructed by the Schuylkill Falls Bridge Company, and in 1822 it was carried away by a flood. In 1829 a similar bridge was constructed by the same company, and in 1842 it was destroyed by fire. In 1878 a wooden bridge known as the "Old Red Bridge" was washed away by a freshet. In 1893 part of another wooden bridge was blown into the river by a wind and rain storm.

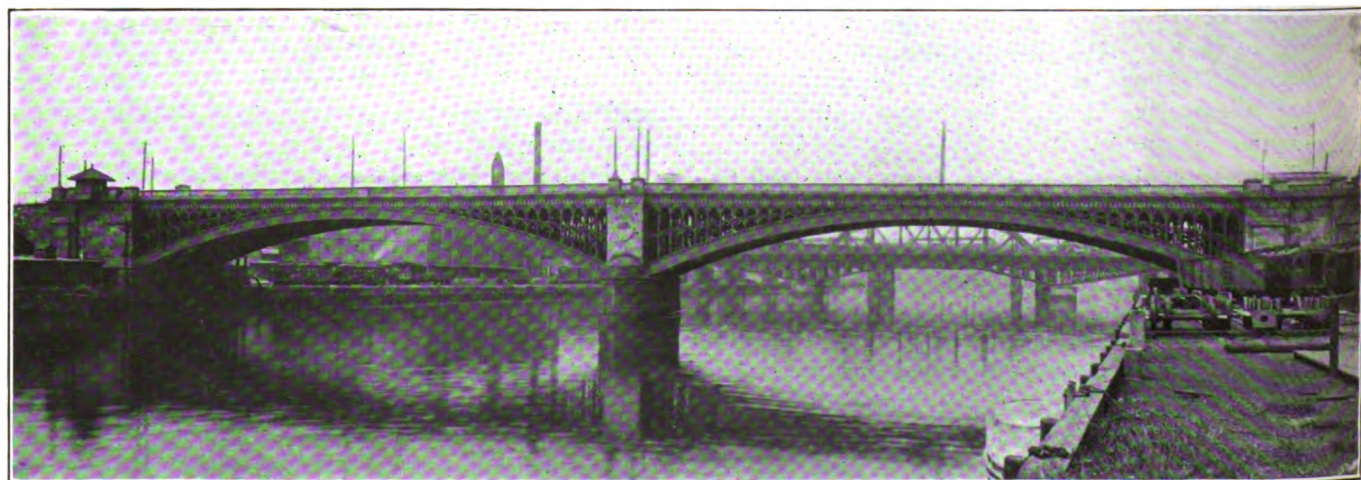
In 1894 construction was commenced on a steel bridge to replace the bridge destroyed the year before. There are to be two decks, the lower one to connect the two Park River Drives and the upper one to connect the upper reaches of the country on both sides of the river. Only one deck has so far been constructed. There are three 180-foot spans, built at a cost of \$262,000.

The Old Gray's Ferry Bridge was constructed in 1838 by the Philadelphia, Wilmington, and Baltimore Railroad, at a cost of \$200,000. It was provided with a span that rolled back into the covered portion when boats desired to pass. One-half of the bridge was devoted to railroad traffic and the other half to public travel. A toll bridge until 1847, the railroad and the city in that year made an agreement freeing the bridge, the railroad to forever maintain a crossing, for a consideration of \$55,000. Shortly before 1900, however, this agreement was abrogated, and the railroad returned the \$55,000. In 1901 the city built the existing Gray's Ferry Bridge, which is devoted to highway use only. This bridge is of steel and has a total length of 1910 feet. A swing span in the center provides two 75-foot clear openings to river travel. The cost was \$525,000.

In 1852 an Act of Legislature required the city to build a bridge over the Schuylkill River at Chestnut Street. The Chestnut Street Bridge is interesting from the fact that it is of cast iron and is the largest cast-iron bridge in America. The west abutment (the left on the picture) is founded on piles driven through soft river mud, and for this reason the abutment was found incapable of taking the arch thrust. In 1884 this weakness was corrected by sinking four 8-foot wrought-iron tubes to bed rock in the rear of the abutment. Sunk at an angle of 45 degrees from the horizontal, they were, after sinking, filled with concrete. In 1912 the bridge was widened from its original width of 42 feet to 54 feet.

Another bridge, city-built, by Act of the Legislature, is that carrying South Street over the Schuylkill River. The first Act requiring its construction was passed in 1861. For nine years, however, Councils tried every possible means to avoid building the bridge, as it was not considered a public necessity. The city finally defeated at all points in the courts, the bridge was then constructed under the supervision of a commission appointed by the Legislature, and completed in 1876. In 1878 a series of eight arches in the west approach collapsed when an effort was made to correct a settlement of one of the piers. This portion was replaced by a wrought-iron trestle. The bridge is of wrought-iron and has a swing span in the center capable of providing two 75-foot openings to navigation. The total length of the bridge is 2,419 feet. Other old bridges in the city should be mentioned to make a complete history.

Here and there throughout the city we find old wooden bridges which, compared with the present-day bridges of steel and concrete, seem almost to belong to a primitive age. These old bridges are rapidly disappearing, giving place to heavier and larger ones. From 1850 wood had difficulty in maintaining its prestige as bridge material. As loads and spans increased wrought-iron beams or wrought- and cast-iron trusses supplanted timber. The first metal truss in the United



CHESTNUT STREET BRIDGE OVER SCHUYLKILL RIVER

PHILADELPHIA BRIDGES

States was built in Manayunk in 1845 to carry the Reading Railroad over a small creek. In 1891 wrought-iron suddenly fell out of use and steel took its place.

The bridge carrying Sixth Street and Allegheny Avenue over the Richmond Branch of the Philadelphia and Reading Railway, built in 1895, has a superstructure of steel. A notable feature of this bridge is the girder, 123 feet long, which at the time of construction was supposed to have been the longest girder in the United States, and is still the longest in the city. It was shipped from Pittsburgh in one piece, involving transporting it around a ten-degree curve.

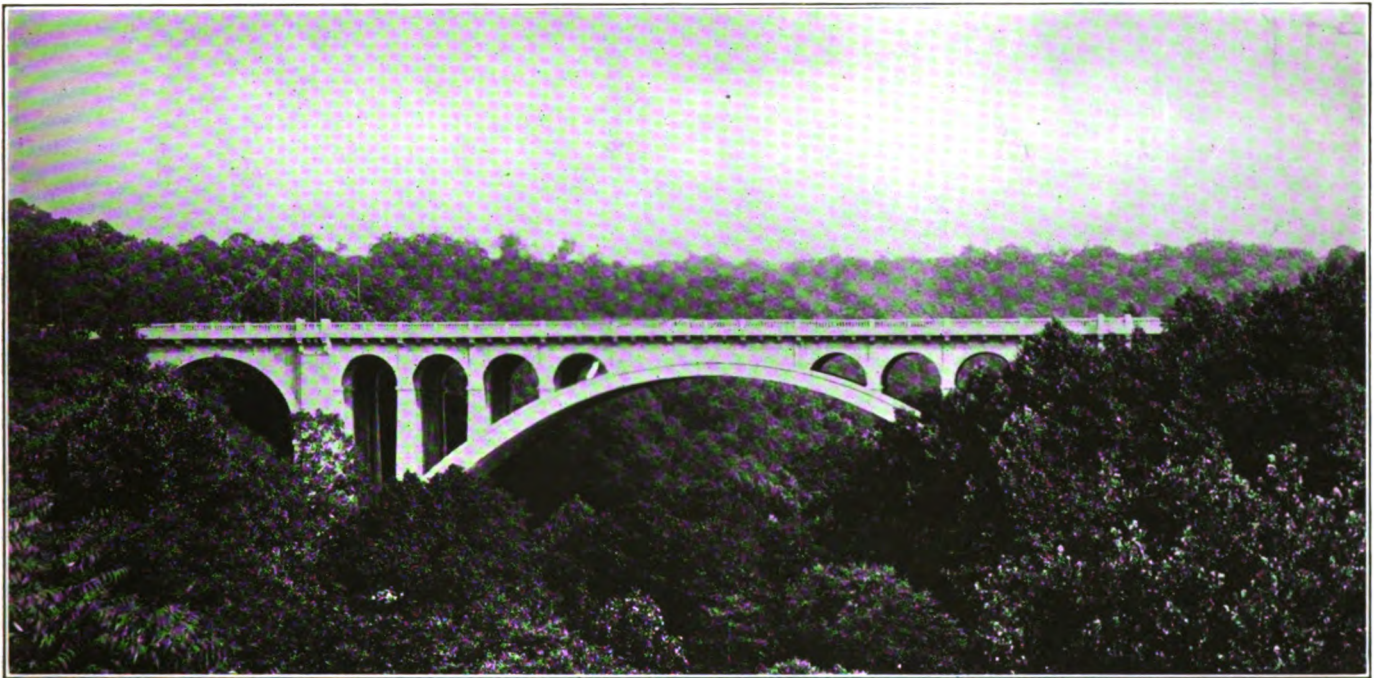
In 1901 the Oak Lane Bridge over the North Pennsylvania Railroad was built and was notable for the concrete abutments. From that time concrete replaced stone masonry for all classes of bridge work almost as quickly as steel replaced wrought iron, and the introduction of this material has resulted in considerable progress in the directions of permanency and appearance.

The problem of protecting bridge superstructures

isfactorily that the practice has been adhered to since.

The Sixty-fifth Street Bridge over the Philadelphia, Baltimore, and Washington Railroad is a steel framework with all the steel covered by concrete, and where the clearance is small, cast-iron blast shields are used to protect the concrete from abrasion. While the first cost is increased by this concrete encasement, the maintenance cost is reduced to almost nothing and the life of the structure is prolonged indefinitely.

The day when a bridge was constructed with only the one object of economy in view has passed. Present practice allows appearance and economy to run hand in hand, neither one overwhelming the other. One of the potent influences in this development has been the adoption of concrete for practically all masonry work. Not only is it a material economical to use, but the method of its use permits almost any desired shape. The physical appearance may be varied by the use of different colored aggregate in the face mixture, and by scrubbing or bush-hammering the face after the forms have been removed.



WALNUT LANE BRIDGE OVER WISSAHICKON CREEK

over steam railways has always been a difficult one. Some form of protection is necessary, if the bridge is to have any permanence, considering the tremendous force of the locomotive blast and also that the smoke consists of steam and gases, both of which deteriorate the metal. In 1897 tests of various paints were made, but none proved satisfactory. The heat dried out the vehicle and the pigment was removed by the force of the blast, leaving the steel exposed to the steam and gases. A one-inch timber ceiling gave better satisfaction. In 1908, however, a bridge constructed at Girard and Belmont Avenues had all the steel work entirely encased in concrete. This served the purpose so sat-

isfactorily that the practice has been adhered to since. It is not always necessary to cover a bridge with elaborate details to give it a fine appearance. For the average bridge the desired result may be obtained by giving the structure well-balanced proportions and by using simple but strong lines.

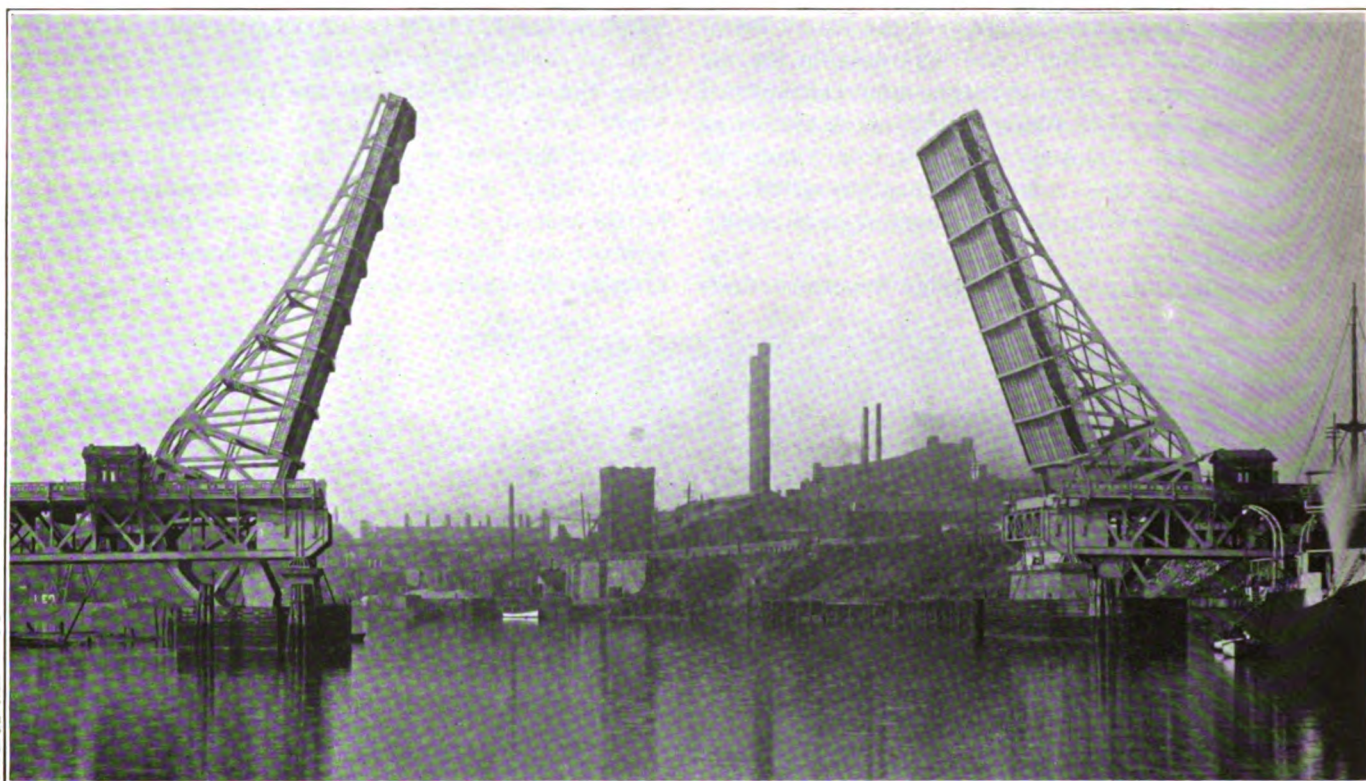
In a recent bridge at Fifty-fifth Street the concrete has been bush-hammered, while the steel is painted white, producing a combination pleasing to the eye. In another bridge, built in 1913, Sixty-sixth Avenue North, the use of colored tile was a feature. The dark mass of concrete was effectively combined with the different colored tile.

The well-known Walnut Lane Bridge over Wissa-

hickon Creek, all of plain concrete, consists of one main arch with a clear span of 233 feet, and five side arches of 53 feet. When the bridge was completed this main arch was the largest plain concrete arch in the world. Its span has since been exceeded by other similar arches, but it still ranks high in the notable bridges of the country. It was completed in 1907, at a cost of \$270,000.

Another notable bridge is that carrying Passyunk Avenue over the Schuylkill River. It has a movable span of the bascule type, thus providing, with the leaves

of reinforced concrete, however, resulted in more rigid monolithic construction, with the result that in many cases these three laws were not sufficient. For continuous beams and girders the theorem of three moments can be used with the desired results, while in more complex structures, such as reinforced concrete arches, the elastic theory is called into action. Another method which can occasionally be used is that of least work. This method is based on the theory that in any structure supporting certain loads the internal work performed by that structure is a minimum.



PASSYUNK AVENUE BRIDGE OVER SCHUYLKILL RIVER—BASCULE SPAN

raised, a 200-foot-wide passage for navigation. This bridge, erected in 1911, cost, including approaches, \$590,000.

One feature of bridge design to-day is the tendency for economy in the use of cantilever construction, wherever practical, in preference to simple beams and girders.

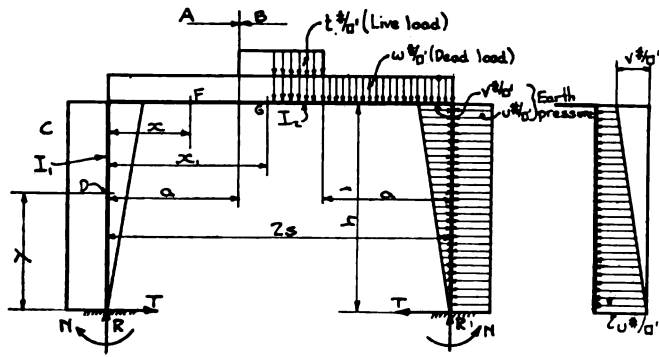
The west approach of Passyunk Avenue, under construction, consists of eight 100-foot plate girder spans designed according to the cantilever principle. The Seventy-second Street Bridge has the same principle applied to a smaller bridge. The interior plate girders are the cantilevers, and the two side spans are the anchor spans. The suspended span is located in the middle span.

For a long time the average structure to be designed consisted of a mere framework of beams, girders, and columns, in which all stresses could be readily determined by means of the three well-known laws of physics— $\sum V = 0$, $\sum H = 0$, and $\sum M = 0$. The use

In other words, the structure does not do any more work than absolutely necessary to support the loads. If, then, we express the internal work in terms of one or more unknown quantities and equate the first derivative to zero, we obtain equations containing those unknown quantities, from which their values can be determined.

Fig. 22 shows an application of this theory. The structure is entirely continuous throughout and the ends are fixed so that the moments, N , can be developed. From symmetry, the two T 's, N 's, and R 's are equal, and from $\sum V = 0$, $R = t(s-a) + \omega s$. The problem then is to determine values for T and N , after which the moments throughout the structure can be computed.

The horizontal loading is assumed to be earth pressure, and to have a value of u pounds per square foot at the bottom, decreasing uniformly to a smaller quantity at the top, as indicated in the sketch on the right. In the analysis, however, a constant pressure



of u pounds per square foot was assumed to act uniformly to the top and the resulting error corrected by applying a load in the opposite direction, varying from zero at the bottom to v pounds per square foot at the top. The structure is designed for a transverse width of one foot.

In the general equation for work, M equals bending moment, E equals modulus of elasticity, I equals moment of inertia, and l equals length of beam considered. From this general equation an expression is obtained for the total work in the structure. Considering the forces below D , we can derive an equation for the moment in the column, and, considering the forces to the left of F and G , we can derive equations for the moments in the slab. Differentiating the equation of total work with respect to N , equation (1) is derived, containing N and T , the two unknowns. Similarly, differentiating the equation with respect to T , another equation containing N and T is obtained. From these the equation is derived which contains T only. Finally, having T , we can easily determine N , and then the bending moment in any point in the structure can be determined.

It will be noted that the above method applies only for symmetrical loading, as otherwise the N 's and T 's would not be equal. The method can hardly be called impractical for that reason, however, for the loads themselves are nearly always symmetrical for highway bridges, and the inaccuracy of placing the loading symmetrical on the bridge to produce the maximum bending moment is not considerable.

$$\text{General equation for work in beam} = \int_0^l \frac{M^2 \delta x}{2EI}$$

$$\text{Total work in structure} = W = 2 \int_0^h \frac{M_c^2 \delta y}{2EI_1} + 2 \int_0^a \frac{M_A^2 \delta x}{2EI_2}$$

$$+ 2 \int_0^s \frac{M_B^2 \delta x_1}{2EI_2}$$

$$M_c = N - Ty - \frac{uy^2}{2} + \frac{vy^3}{6h}$$

$$M_A = N - Th + Rx - \frac{ux^2}{2} + \frac{vx^2}{6} - \frac{wx^2}{2}$$

$$M = N - Th + Rx_1 + \frac{ux^2}{2} + \frac{vx^2}{6} - \frac{wx_1^2}{2} - \frac{t(x_1 - a)^2}{2}$$

$$\frac{\delta W}{\delta N} = 2 \int_0^h \frac{\delta y}{2EI_1} 2M_c \frac{\delta M_c}{\delta N} + 2 \int_0^a \frac{\delta x}{2EI_2} 2M_A \frac{\delta M_A}{\delta N}$$

$$+ 2 \int_0^s \frac{\delta x_1}{2EI_2} 2M_B \frac{\delta M_B}{\delta N} = 0$$

$$\frac{\delta M_c}{\delta N} = 1 \quad \frac{\delta M_A}{\delta N} = 1 \quad \frac{\delta M_B}{\delta N} = 1.$$

$$\text{Let } J + \frac{I_2}{I_1} = \frac{s}{Jh + s} \quad r = \frac{a}{s}.$$

$$J \int_0^h M_c \delta y + \int_0^a M_A \delta x + \int_0^s M_B \delta x_1 = 0$$

$$N = \frac{Th}{2}(1+f) + \frac{uh^2}{6}(1+2f) - \frac{vh^2}{24}(1+3f) - \frac{ws^2f}{3} - \frac{ts^2f}{6}(2-3r^2+r^3)$$

(1)

$$\frac{\delta W}{\delta T} = 2 \int_0^h \frac{\delta y}{2EI_1} 2M_c \frac{\delta M_c}{\delta T} + 2 \int_0^a \frac{\delta x}{2EI_2} 2M_A \frac{\delta M_A}{\delta T} + 2 \int_0^s \frac{\delta x_1}{2EI_2}$$

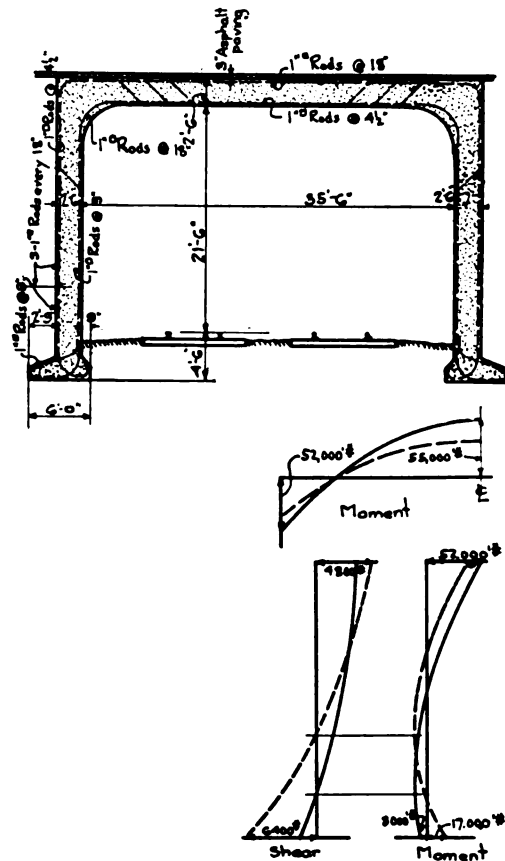
$$2M_B \frac{\delta M_B}{\delta T} = 0 \quad \frac{\delta M_c}{\delta T} = -y \quad \frac{\delta M_A}{\delta T} = -h \quad \frac{\delta M_B}{\delta T} = -h$$

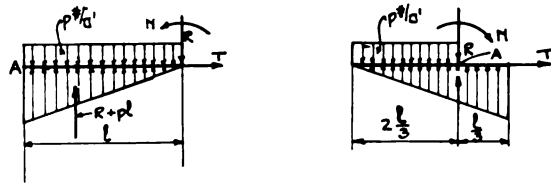
$$J \int_0^h M_c (-y) \delta y + \int_0^a M_A (-h) \delta x + \int_0^s M_B (-h) \delta x_1 = 0$$

$$\text{Let } m = \frac{s}{Jh + 4s}$$

$$T = -\frac{uh}{2}(1+m) + \frac{3vh}{20}(1+2m) + \frac{2ws^2m}{h} + \frac{ts^2m}{h}(2-3r^2+r^3)$$

APPLICATION OF THEORY OF LEAST WORK





$$N - P \frac{P}{6} - \frac{2Rl}{3} = 0 \quad N - \frac{2PP}{9} - 0$$

$$l = \sqrt{\frac{6N}{P} + \left(\frac{2R}{P}\right)^2} - \frac{2R}{P} \quad l = \sqrt{\frac{9N}{2P}}$$

PRACTICAL DESIGN, USING THEORY OF LEAST WORK

The illustration shows a design made from the formulæ just derived. The live load was taken at 40 tons, distributed over a rectangle 5 feet long by 10 feet wide. t therefore equals 800 pounds per square foot and a equals 19 minus 2.05, or 16.5 feet. Two values of earth pressure were considered—one 0.15 of the vertical pressure and one 0.30 of the vertical pressure. Earth was assumed to weigh 100 pounds per cubic foot. u , maximum, therefore, equals $0.3 \times 100 \times \text{height}$ (26 feet), or 825 pounds per square foot. v , maximum, equals u minus $0.3 \times 100 \times 2.5$, or 780 pounds per square foot. The minimum values are one-half of these. The structure is of reinforced concrete. Steel was allowed a stress of 12,000 pounds per square inch, and concrete 500 pounds per square inch. The concrete will take all the shear with a maximum stress of 30 pounds per square inch. The rods are bent to take stress on opposite sides of the beam. Three cases were considered: Maximum earth pressure and full live load; minimum earth pressure and full live load (shown by full lines on the bending moment and shear diagrams); and maximum earth pressure and no live load (shown by dotted lines on the diagrams).

The horizontal thrust is taken by friction between the base and the rock or soil. In order to enable the structure to develop N , a horizontal slab and toe was attached at the bottom of the vertical wall. This is somewhat analogous to a retaining wall of the cantilever type. The required length of this slab can very easily be determined. The drawings at the bottom of the illustration indicate the forces that act on it, each one showing the economic position for R for the corresponding direction of N . R , T , and N have the same values as determined for the structure itself, except that R should be increased by the weight of the vertical wall. l , for safety, should be of such length that the pressure on the soil will vary from twice the average at the point of overturning to zero at the other end. Taking moments about A in each case, we obtain the equations given from which l can readily be determined.

Incidentally, a simple slab on this span would require a depth of 42 inches, so that this design not only saves considerable material but greatly increases the clearance over the top of rail.

It is desirable that the structure should be poured in one continuous operation, inasmuch as a bending

moment exists throughout the structure and construction joints in the concrete would be objectionable. The liberal use of steel rods, however, would lessen this objection, so that one or two joints in the wall could be permitted. The structure can therefore be termed entirely practical. Whether it would be preferred over a reinforced concrete arch, a steel frame encased in concrete, or some other type of structure is largely a matter of choice, depending on the relative economy and its adaptability to the particular site.

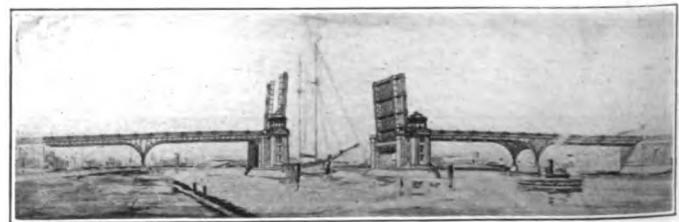
One of the newer large bridges, under construction, will carry Bensalem Avenue, a branch of the Northeast Boulevard, over Pennypack Creek. This bridge is on the line of the Lincoln Highway and is within the bounds of Pennypack Park. Architecture played a large part in the design of the structure. The



BENSALEM AVENUE BRIDGE OVER PENNYPACK CREEK

concrete surfaces will be scrubbed, exposing small buff-colored pebbles, giving a color blend with the surrounding natural landscape. The arches are semicircular and of plain concrete, the middle arch having a clear span of 100 feet and the side arches 60 feet. The cost will be about \$200,000.

The proposed plan for the new South Street Bridge over the Schuylkill River provides a 100-foot clear bascule span in the center and the girders between this span and each shore are designed on the cantilever principle.



FUTURE SOUTH STREET BRIDGE OVER SCHUYLKILL RIVER

The plan of the proposed arch carrying Henry Avenue over Wissahickon Creek provides for a main span of 335 feet. If constructed, it would be the largest concrete or stone arch in the world. If built of plain concrete the probable cost would be \$400,000.

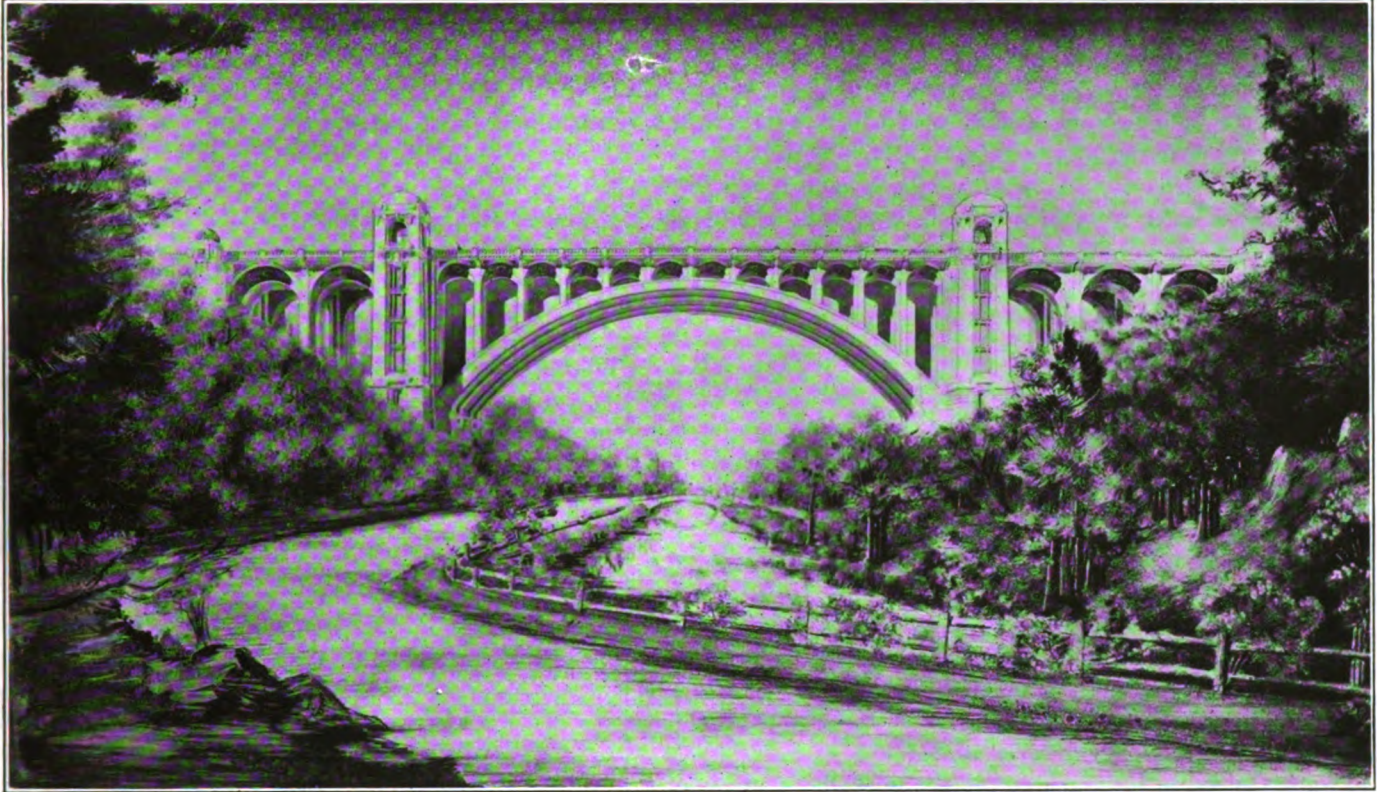
The last of Philadelphia's possible future bridges to be mentioned is the proposed bridge over the Delaware River, connecting Camden and Philadelphia. This is not by any means a new project. One hundred years ago a company was formed for the construction

PHILADELPHIA BRIDGES

of such a bridge, and since then, from time to time, different and unique designs have been proposed.

In 1851 Mr. John C. Trautwine designed a suspension bridge of four 1000-feet and two 500-feet spans. Later, in 1868, Roebling, of Brooklyn Bridge fame, proposed a suspension bridge of four spans. His design called for two branches at one end, each of which

with movable span make such a bridge almost impractical. Again, it should be of the suspension type, as the nature of the loading would not warrant a heavy, unsightly cantilever structure. If practical, no piers should be placed inside the pier-head lines. This will necessitate a span of 1970 feet, larger than any yet constructed. It exceeds the Firth of Forth cantilever,



PROPOSED HENRY AVENUE BRIDGE OVER WISSAHICKON CREEK

contained a draw span. The idea was that one could always be kept closed while the other was open, and there would be no interruption of either bridge traffic or river navigation.

Investigation by the Bridge Division of the Bureau of Surveys indicates that the most desirable structure should be a bridge of high level, probably 135 feet above the river. Continued interruptions in a low level bridge

in Scotland, by almost 260 feet, and the Brooklyn Suspension Bridge by 375 feet, but such a span is considered entirely feasible. The estimated cost is \$18,000,000.

As engineers, we can but hope that the many and far-reaching advantages of a Philadelphia-Camden Bridge will place it in the category of future bridges and will be sufficient to merit its construction.

DISCUSSION

BY HENRY H. QUIMBY

The subject is a large one, because of the great area of the city, with its numerous streams and railroads to be crossed, the many years during which it has had to build bridges, and the almost infinite variety in the character and design of those that have been built, but Mr. Kline has covered it admirably and in a comprehensive way.

By way of discussion I might elaborate on what the paper describes as one of the steps in our development of the present-day practice in bridge construction.

The bridge over the Pennsylvania Railroad at Belmont and Girard Avenues, which Mr. Kline mentioned as one of the early bridges where the steel was entirely encased in concrete to protect it from the fumes of locomotives, is one of very large floor area, but has very little girder work in it; it is almost all floor work, due to the fact that it carries two wide avenues intersecting exactly over the nine tracks of the railroad. The bridge is very low—the under side of it very close

(Continued on Page 384)

LAYOUT OF MACHINE TOOLS FOR A LARGE LIGHT MANUFACTURING PLANT

BY DAVID J. MATLACK

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THE procedure outlined is especially adapted to the layout of a plant manufacturing a standardized product in large quantities, but most of the principles are applicable to any plant.

The problem will be discussed under the following headings:

1. The method of scheduling machine operations briefly explained, this being the foundation of the layout.
2. Comparison of two general methods of layout:
 - (a) By grouping all machines of one kind together.
 - (b) By arranging the machines in the same sequence as the operations of the parts machined.
3. Preliminary layout studies.
4. Arrangement of the layout drawings.
5. The power layout.

1. *Schedule Explained.*—The chart shows the method of scheduling the operations, and is almost self-explanatory. Skipping the operations which take place in the forging shop, the blank is received ready for the first machining operation (Operation 1). The following sketches show the stages through which it passes until it is completely finished, as shown in the last operation. The column of "machine used" shows that operations using one kind of machine are not grouped together. This is because the sequence is determined from the fact that one cut is located by means of the surfaces previously finished. Thus the two holes at right angles to each other are completed early in the list, in order to locate the piece in the fixtures for the operations which follow.

The next column gives the number of pieces produced by one machine in an hour. This figure is found by time studies, which include a consideration of cutting speeds, kind of cut and machine, and many other factors. The correctness of the whole layout depends on the accuracy with which this figure has been determined.

The last column gives the number of machines to maintain the required output. This is not merely a problem in short division. It may be expressed somewhat as follows:

$$\text{Number of machines} = (a) \frac{\text{Required output per hour.}}{\text{Output of one machine.}}$$

+ (b) Allowance for spoiled work + (c) Allowance for repairs + (d) Allowance for variation between day and night shifts + (e) Allowance for inaccuracies in estimate of the output of one machine + (f) Allowance for expansion of plant.

(a) The first term can be easily found (assuming that its denominator has been calculated), but the others must be estimated.

(b) The allowance for spoiled work depends not only on the quality of the steel, the cutter, and the workman, but also on the location of the particular operation in the schedule. For example, if one per cent. is spoiled in

SCHEDULE OF OPERATIONS AND MACHINES

Oper. No.	Sketch of Cut	Name of Oper.	Mach.	Pcs. per hr.	No. of Mach.	Remarks
1		Mill sides rgh.	Power Miller	20	20	
2		Mill back rgh.	Power Miller	20	19	
3		Drill & ream pin hole	Drill Press	10	39	39 Spindles
4		Mill front	Hand Miller	12	33	
5		Drill & ream hole in lug.	Drill Press	30	13	
6		Mill sides, finish	Power Miller	20	19	
7		Drill corners of slot	Drill Press	10	38	38 Spindles
8		Mill sides of slot	Hand Miller	15	25	
9		Mill ends of slot	Hand Miller	25	15	
10		Profile slot	Profiler	12	31	31 Spindles
11		Profile lug and bolt cut	Profiler	15	25	25 Spindles
12		Mill front of lug	Hand Miller	25	15	
13		Mill back	Hand Miller	25	15	
14		Mill back, finish	Power Miller	20	19	
15		Mill top	Power Miller	30	12	

each operation, the last operation need only provide for starting 101 per cent. pieces, but the first operation will have to provide many more, depending on how many operations there are. Thus, for our example of 15 operations, if one per cent. of the pieces starting each operation is spoiled during it, the first operation must provide 116.3 per cent. The number necessary to start the first operation mounts up very rapidly. Thus, for a piece of 69 operations, 200 per cent. of the final output must be started. The figure of one per cent. is not intended to

be an actual average—it is much too high for many cases—but there are conditions under which it would be greatly exceeded.

(c) Allowance for repairs, etc., can best be expressed as a percentage of item (a), but there should always be provision for at least one idle machine in each operation group.

(d) Night work is not as efficient as day work, and, as the denominator of the first term (a) in the equation is figured for daytime conditions, in order to maintain the average output for the entire 24 hours it is either necessary to provide more machines for the slower night gang, or, better, to provide for the day force turning out, say, 60 per cent. of the work, the night force 40 per cent. This means that 20 per cent. additional machines must be provided (assuming 2 shifts).

(e) If the estimator was off in his time study, the basis of the whole estimate falls down. In the case of a new or enlarged plant for a product already manufactured for some time, the figure should not be far wrong; in the case of a new product, it may be as much as 100 per cent. in error, as the time studies would have to be made under conditions that only approximate actual working conditions.

(f) Allowance for expansion is, of course, a definite percentage of the sum of the other items, and is used to provide space in the layout for additional machines which may be purchased later to increase the output or to bring the output up to the required amount, in case the entire first estimate is found to be too low, after the plant starts running.

For illustration, the following percentages will be added to the results of the first item in the equation:

Spoiled work—10 per cent. for first six operations, 5 per cent. for remainder.

Repairs—5 per cent.

Day and night variation—20 per cent.

Other items—None.

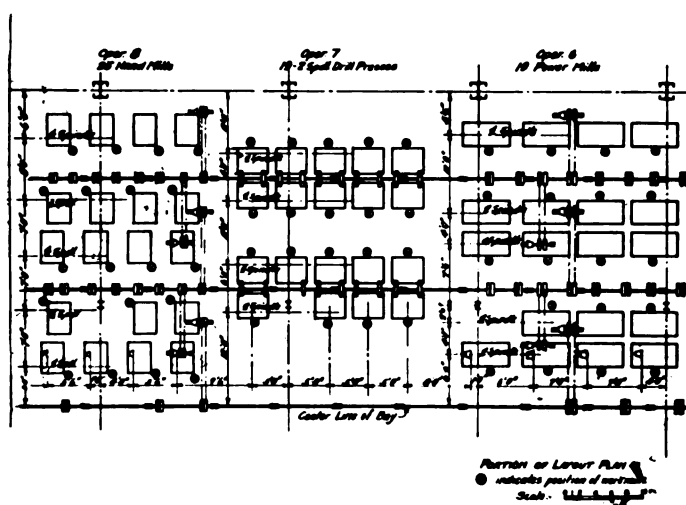
The results are tabulated in the last column of the chart for an assumed average hourly output of 300 pieces.

2. *Types of Layout.*—No matter what type of layout may be selected, the above method, or one giving similar results, must be pursued, in order to form any estimate of the number and kind of machines needed. The next question is to decide which of two general forms the layout shall take:

(a) By grouping all machines of one style together, or (b) arranging the machines by operations, so that the piece being machined passes from one operation group to another in a direct line through the shop.

The advantages and disadvantages of each method will be noted briefly:

Advantages of (a): The work of superintendence, repair, setting up, and operation of each style of machine is concentrated, instead of being scattered all over the shop in batches of 10 machines here, 12 there, etc. Thus the foremen can be specialists in the ills that one kind of machine and one class of operators are heir to, in-



stead of having to be general practitioners for all varieties. The work of setting up (that is, arranging the fixture or jig, and the cutter) is generally handled by a special gang, the machine operators having nothing to do with this. Having the machines concentrated helps out in this work.

A smaller total of machines is required because the error in determining the number of machines for one operation tends to balance the error on the other side for another operation, so that there is elasticity—a give and take—between the operations.

There is an economy of floor space, as there is no space wasted between the operation groups on account of the difference in shape and sizes of the adjacent machines. The arrangement of the shafting is also greatly simplified.

It is sometimes desirable to change the sequence of operations, or to combine two or more, or to change the style of a fixture so as to require a different machine, and this type of layout has the elasticity to permit these adjustments to be made very easily.

Economy of power is also obtained, assuming that a group of machines is driven by one motor, as all the idle machines of one kind can be grouped together.

This form of layout provides for a slight change in the parts manufactured, or for entire change of output, without rearranging the whole plant.

The above advantages of plan (a) are also the disadvantages of the second type of layout, and the disadvantages of the first are included in the advantages of plan (b), which are as follows:

Simplicity of Routing.—The piece travels from one group of machines to the next, with no back trips, the total distance traveled being a minimum. Where the parts manufactured are large, so that a crane is necessary to transfer them from place to place, this consideration alone outweighs all the disadvantages of the method. As the size diminishes to the point where several score, or even several hundred, pieces can be loaded on a small shop motor truck, and carried rapidly and cheaply to the next operation, the importance of this point diminishes.

(Continued on Page 387)

CODE OF LIGHTING*

FACTORIES, MILLS AND OTHER WORK PLACES

PREFACE

The following Code of Lighting for Factories, Mills and other Work Places, has been prepared by committees of the Illuminating Engineering Society in order to make available authoritative information for legislative bodies, factory boards, public service commissions and others who are interested in enactments, rules and regulations for better lighting.

While the code is intended as an aid to industrial commissions and other similar bodies in those states and municipalities which shall actively take up the questions of legislation as related to factory and mill lighting, it is intended in equal measure for the industries themselves as a practical working guide in individual efforts to improve lighting conditions. The language of the code has not been drafted according to legal phraseology but is simple and pointed throughout, thus being readily available for transforming into legal orders, and at the same time as a working guide in practical design and installation work.

ARTICLE I. DAYLIGHT.—All buildings hereafter constructed must be provided with adequate window areas. Awnings, window shades, diffusive or refractive glasses must be used for the purpose of improving daylight conditions or for the avoidance of excessive brilliancy wherever they are essential to these ends.

The windows, skylights, saw-tooth or other roof lighting constructions, are to be arranged with reasonably uniform bays, and the daylight openings shall be so designed and proportioned that at the darkest part of any work space, when normal exterior daylight conditions obtain, there shall be available at least a minimum intensity equal to three times the minimum intensities given in Article V for artificial light.

(NOTE: The intensity requirements for daylight are higher than those for artificial light because the physical condition of the eye during the daytime is usually such as to require a higher intensity of natural light for satisfactory vision than is required at night under ordinary well-designed artificial lighting systems.

ARTICLE II. Old buildings at present constructed and not having adequate window area, must be provided with adequate artificial light according to the following articles, so as to supplement the natural light during normal daylight hours.

ARTICLE III. All buildings, whether old or hereafter constructed, must be provided during those hours of work when natural light is insufficient or not available, with adequate artificial light according to the following articles.

ARTICLE IV. Adequate intensity of the light must

be provided for each class of work, both on a horizontal plane as well as on a vertical plane passing through the work, according to Article V. In all cases, however, glare on working surfaces is to be avoided as it tends to reduce the visual efficiency of the workmen and to increase the likelihood of accidents.

ARTICLE V. ARTIFICIAL LIGHT; *Intensity Required.*—The average illumination intensity throughout any month actually measurable in foot-candles on a horizontal plane through the work is to conform to the following table. Uncertain cases which arise as to how to classify given manufacturing operations are to be left to the judgment of a lighting expert.

Class of work	Minimum foot-candles intensity	Desirable foot-candles intensity
Storage, passageways, stairways, and the like	0.25	0.25- 0.5
Rough manufacturing and other operations	1.25	1.25- 2.5
Fine manufacturing and other operations...	3.50	3.5 - 6.0
Special cases of fine work.....	—	10.0 -15.0

Where operations are performed on the sides of the work in hand, they shall be classified according to this table, and if the illumination is furnished from an overhead system, it shall preferably *be not less than 50 per cent.* of the foregoing values, when measured on a vertical surface. If the illumination is furnished by an individual lamp or by lamps close to the work, the intensity shall conform to the minimum or desirable intensities required in the foregoing table.

(NOTE: As a guide to inspectors and others, it may be stated that with modern lamps roughly 1 candlepower per square foot produces an effective illumination of 3 foot-candles when the lamps are arranged according

*Courtesy of the Illuminating Engineering Society.

to the uniformly distributed overhead system, with mounting heights ranging from 12 to 16 feet above the floor, when the light is directed from said lamps to the work in an efficient manner. A rough idea may thus be secured of the candlepower per square foot necessary to conform to the foregoing table of intensities by taking *one-third of the intensity values given in the foregoing table.*)

Thus for fine manufacturing and other operations, the minimum foot-candle intensity is 3.5, which is approximately equal to 1.2 candlepower per square foot. The use of a portable photometer or illuminometer, however, is recommended for the determination of existing systems and all uncertain cases are finally to be established by these instruments.

ARTICLE VI. *Lamps and machinery* jointly are to be so arranged as to avoid the casting of shadows over belts and other obstructions on important parts of the work, and the distribution of light from the lamps should be such as to avoid sharp contrasts of light and shade on the work.

ARTICLE VII. *Inspection and regular maintenance* of all lighting systems is required in spaces where work is being conducted, and in no case must the lighting devices, whether windows, lamps or auxiliaries such as globes and reflectors, be allowed to deteriorate, due either to dirt accumulations or to burned-out lamps, more than 20 per cent. below the minimum intensity values required by Article V.

ARTICLE VIII. *Roadways, yards and places not usually frequented* must either be provided by illumination during working hours when natural light is absent or partly absent, to make them safe against accident to employees traversing or engaged in such places, or a convenient control or controls must be placed at the entrance to basements, stock rooms, and the like, so that a person on entering can readily turn on the lamps beforehand.

ARTICLE IX. *Stairways and passageways* must be provided with lamps and reflectors or shades carefully located so as to shed their light generally over the entire space or spaces involved, and in sufficient quantity to make the stairways and passages safe against accident to employees traversing or engaged in such places. For intensities see Article V.

ARTICLE X. Each working space is preferably to be illuminated by lamps mounted overhead according to the system of general lighting, in preference to individual lighting. The overhead method of lighting, besides possessing many other advantages, also tends to reduce dark spots throughout the floor area, a feature usually objectionable with the use of individual lamps. This particular Article is not an absolute require-

ment, but a suggestion enforceable at the discretion of a lighting expert.

ARTICLE XI. *Auxiliary lighting* should be provided in all large work spaces, such lamps to be in operation simultaneously with the regular lighting system, so as to be available in case the latter should become temporarily deranged.

EXPLANATORY RULES

The foregoing articles are supplemented by the following rules, which will aid in the observance of the requirements contained in the articles; tend to reduce eye trouble and accidents; and help in the securing of favorable results in planning lighting systems.

1. Lamps should be equipped with reflectors or shades for minimizing glare and economizing light. Bare lamps should not be used except in rare cases and then only when out of the line of vision.

2. As a general plan, mount the lamps high and out of the ordinary line of vision.

3. Although the types of reflectors and shades, and reflector and shade holders or fitters on the market are numerous, it is recommended that the holder or fitter, as well as the reflector or shade be selected with reference to placing the light source at the proper point in the reflector or shade so as to eliminate glare, due to exposure of the light source, and also for the purpose of directing the light from the lamp effectively to the work; that is, for obtaining a distribution of light which meets the desired requirements.

4. Light thrown vertically downward is not the only important component of the resulting illumination. The sides of machinery, machine tools and work, as well as horizontal surfaces often require good light.

5. Control few lamps in each group, so that lamps not needed may be turned off conveniently.

6. Keep windows, lamps and reflectors clean, since large losses of light result from the accumulations of dust and dirt.

7. Provide a maintenance department if the shop is large enough to warrant it, so that all the items associated with the upkeep of the lighting system may be cared for systematically.

8. Keep ceilings and upper portions of walls a light color for the purpose of rendering both natural and artificial lighting more efficient and better diffused. The lower portions of walls should be a color which is restful to the eyes, preferably a medium tint, typified by the tint known as *factory green*, or a rather dark shade of yellow. Other medium tones are also available.

EXPLANATORY NOTES

SECTION I. DAYLIGHT.—Adequate daylight facilities through large window areas together with light, cheerful surroundings, are highly desirable and necessary

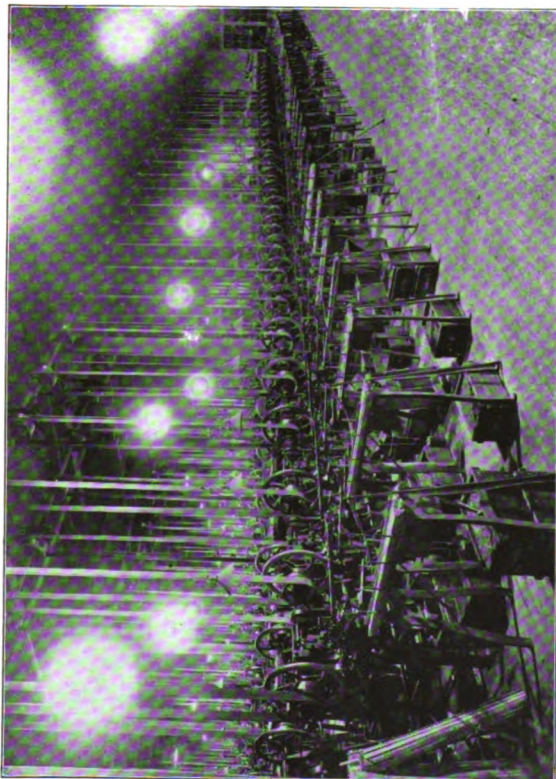


FIG. 3.—NIGHT VIEW OF A RATHER LOW FACTORY SECTION, SHOWING TUNGSTEN LAMPS OF THE 250-WATT SIZE MOUNTED 12 FEET ABOVE THE FLOOR. NOTE THE ORIGINAL INDIVIDUAL LAMPS OVER THE MACHINES.



FIG. 5.—DAY VIEW OF A GAS-LIGHTING INSTALLATION IN A LOW FACTORY SECTION. THIS PHOTOGRAPH SHOWS MERELY THE GENERAL ARRANGEMENT OF LAMPS AND GIVES NO IDEA OF THE ILLUMINATION EFFECT.

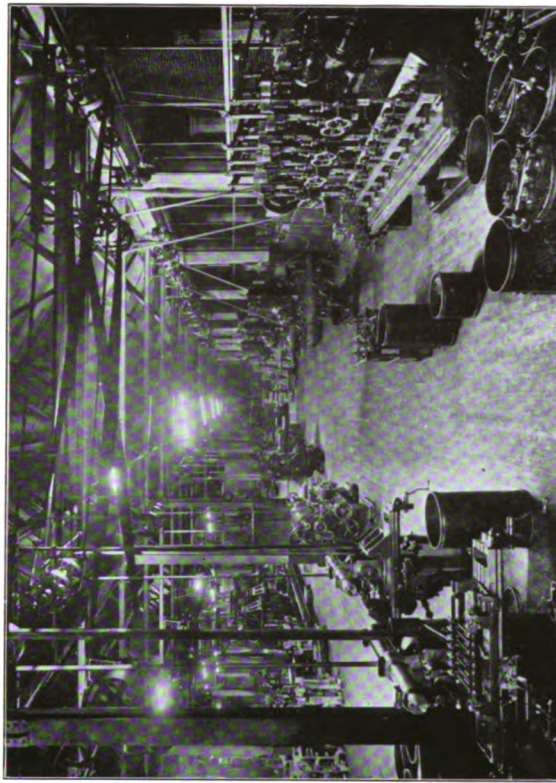


FIG. 4.—NIGHT VIEW, SHOWING MERCURY-VAPOR LIGHTING IN LOW FACTORY SECTION. THE LAMPS ARE ABOUT 12 FEET ABOVE THE WORK. NOTE THE COMPARATIVE ABSENCE OF SHADOWS.

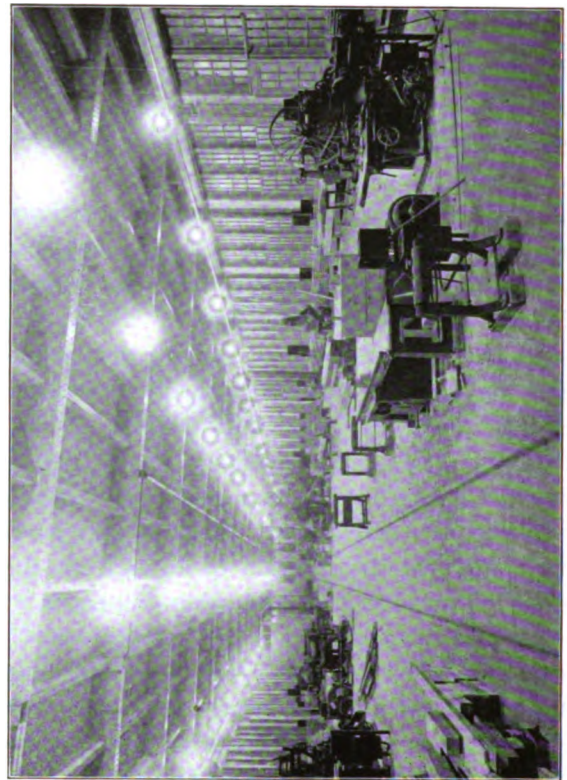


FIG. 6.—NIGHT VIEW OF A PLANING MILL, SHOWING AN INSTALLATION OF 250-WATT TUNGSTEN LAMPS WITH A 16-FOOT MOUNTING. NOTE THE EXCELLENT DISTRIBUTION OF THE LIGHT AND THE COMPARATIVE ABSENCE OF SHADOWS. THIS IS AN EXAMPLE OF THE OVERHEAD METHOD OF LIGHTING.

features in every work place, and they should be supplied through the necessary channels, not only from the humane standpoint, but also from the point of view of maximum plant efficiency.

Importance of Daylight.—The unusual attention to gas and electric lighting in factories, mills and other work places during the past few years; the perfection of various lamps and auxiliaries by means of which an improved quality and quantity of lighting effects are obtained; and the care which has been devoted to increasing the efficiency in various industrial operations—all go to emphasize the many advantages and economies that result from suitable and adequate window space as a means for daylight in the proper quantities and in the right directions during those portions of the day when it is available.

Three Considerations.—Three important considerations of any lighting method are *sufficiency*, *continuity* and *diffusion*. With respect to the daylight illumination of interiors, *sufficiency* demands adequate window area; *continuity* requires (a) large enough window area for use on reasonably dark days, (b) means for reducing the illumination when excessive, due to direct sunshine, and (c) supplementary lighting equipment for use on particularly dark days and especially towards the close of winter days; *diffusion* demands interior decorations that are as light in color as practicable for ceilings and upper portions of walls, and of a dull or mat finish in order that the light which enters the windows or that which is produced by lamps may not be absorbed and lost on the first object that it strikes, but that it may be returned by reflection and thus be used over and over again. Diffusion also requires that the various sources of light, whether windows, skylights or lamps, be well distributed about the space to be lighted. Light colored surroundings as here suggested result in marked economy, but their main object is perhaps not so much economy as to obtain a result that will be satisfactory to the human eye.

Requirements.—The following requirements may now be listed for natural lighting:

1. The light should be adequate for each employee.
2. The windows should be so spaced and located that daylight conditions are fairly uniform over the working area.
3. The intensities of daylight should be such that artificial light will be required only during those portions of the day when it would naturally be considered necessary.
4. The windows should provide a quality of daylight which will avoid a glare due to the sun's rays and light from the sky shining directly into the eye,

or, where this does not prove to be the case at all parts of the day, window shades or other means should be available to make this end possible.

5. Ceilings and upper portions of walls should be maintained a light color to increase the effectiveness of the lighting facilities from window areas. The lower portions of walls should be somewhat darker in tone to render the lighting restful for the eye. Factory green or other medium colors may be used to good effect.

Classification.—Means for natural lighting may be classed under three broad divisions, as follows:

(a) That case in which the windows are located on the sides of the building or in the framework of saw-tooth construction, where diffused light from the sky reaches the work during a large portion of the day.

(b) That case in which windows are located overhead on a horizontal or nearly horizontal plane in the form of skylights, thus furnishing direct light from the sky during a large portion of the day.

(c) That case in which prismatic glass takes up the

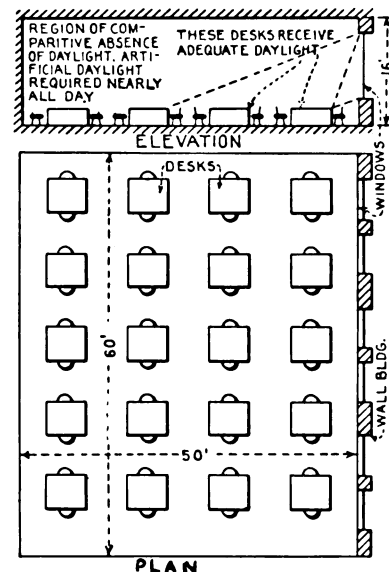


FIG. 1.—DIAGRAM OF A LARGE OFFICE WITH WINDOWS ON ONE SIDE ONLY.

direct light from the sky and redirects it into the working space.

Method (a) is, of course, the most common of the three, and it may be noted that the saw-tooth or other roof-lighting constructions have become very popular and result in an excellent quality and quantity of light for given window areas, provided the size and location of windows are in accord with modern practice.

Increasing the Value of Floor Space.—Adequate and well-distributed natural light means that certain por-



FIG. 7.—NIGHT VIEW OF A BOILER SHOP.

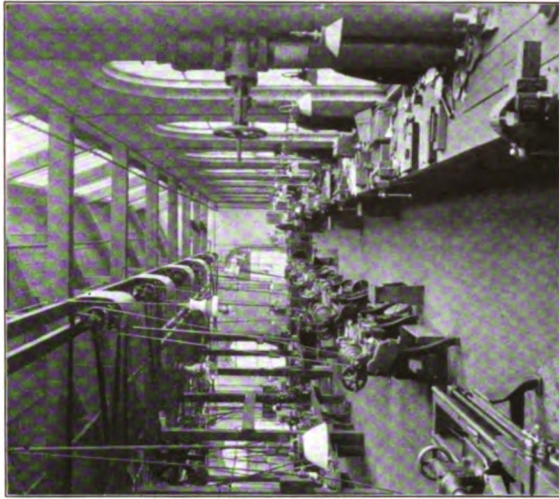


FIG. 8.—DAY VIEW, SHOWING ARRANGEMENT OF GAS LAMPS IN A MEDIUM HIGH FACTORY SPACE. NOTE THE PIERCED REFLECTORS OVER THE MACHINE TOOLS NEAR THE CENTER OF THE PICTURE.

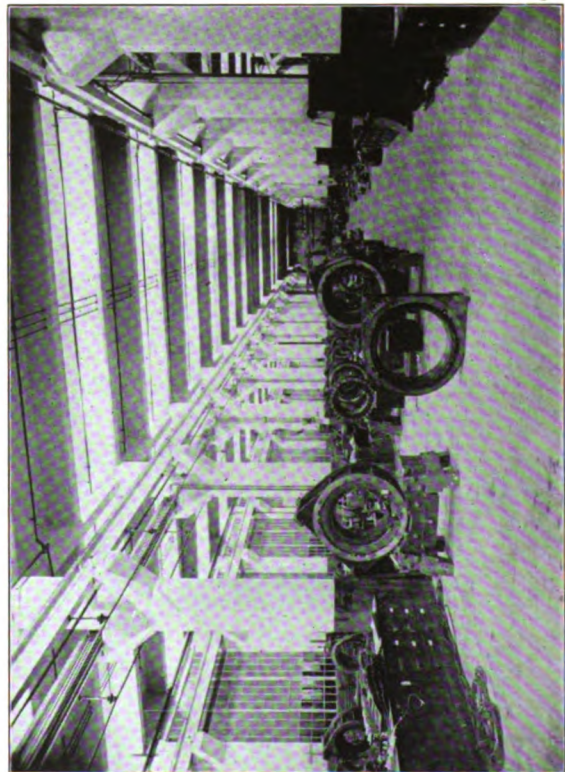


FIG. 9.—NIGHT VIEW OF FACTORY SECTION, WITH RELATIVELY HIGH MOUNTING OF 250-WATT TUNGSTEN LAMPS. THE LAMPS ARE 20 FEET ABOVE THE FLOOR. NOTE THE EXCELLENT DISTRIBUTION OF THE LIGHT AND THE SHIELDING EFFECT OF THE GIRDERS, WHICH SERVE TO REDUCE THE GLARE AS ONE LOOKS DOWN THE AISLE.

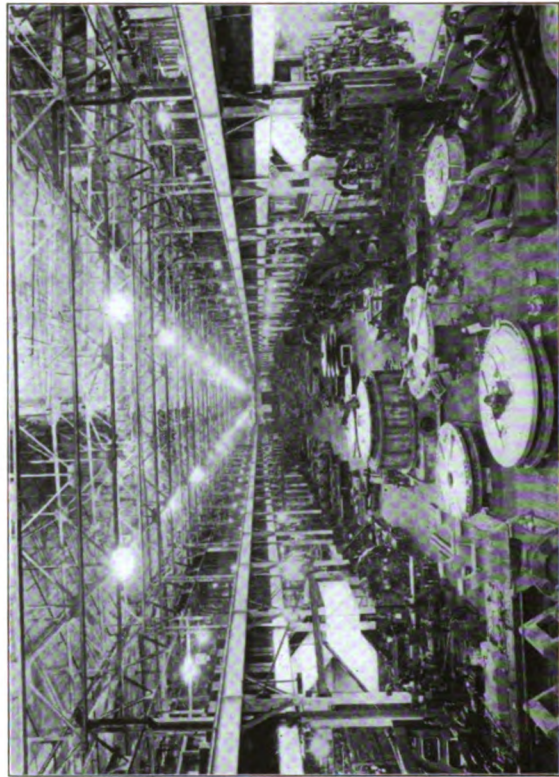


FIG. 10.—NIGHT VIEW OF ARC LAMP INSTALLATION WITH 40-FOOT MOUNTING AT CENTER OF PICTURE AND 20-FOOT AT SIDES. EXCELLENT DISTRIBUTION.

tions of the floor space which ordinarily would not be available for work are converted into valuable manufacturing space. In a general way, therefore, the average factory, mill or other work place, if properly designed, should possess natural lighting facilities which produce the best practicable distribution of daylight illumination.

Wide Aisles.—With low ceilings and very wide aisles, workmen located at the central portion of the building must sometimes depend for their natural light on windows located at a considerable distance away from their working position. In these cases it may be possible, in general, to depend altogether on daylight over an entire floor space, even at those times of day when daylight conditions would be entirely adequate under other circumstances. This statement applies to side windows rather than to skylights or to saw-tooth construction. Fig. 1 illustrates this feature.

Varying Conditions.—In a case of this kind, employees located next to the windows are furnished with suitable daylight in the early morning and towards the latter part of the afternoon, the upper portions of the windows being particularly serviceable in lighting areas at some distance away from the windows. A southern exposure, however, results in such excessive light from the sky during the middle of the day that heavy shades are nearly always pulled down so as to cover the entire window area. This plan makes it necessary to use artificial light throughout the larger part of the office during the brightest portion of the day, and reduces the daylight at those points where it would supposedly be the best, namely, near the windows. Here the location of the windows is a large factor in the excellence of the daylight conditions, but the manipulation of the shades is perhaps even more important. To avoid such a difficulty, adjustable translucent upper window shades with adjustable opaque lower shades might be employed.

Upper Portions of Windows.—It should be further noted in this illustration that the upper portions of the windows give a reduced illumination in proportion to their areas, to the floor space near them. In rooms of moderate size, therefore, the windows should be placed as near the ceiling as practicable. When the sun shines through windows so located, the direct light must be reduced or diffused. This may be accomplished by the use of ribbed glass in ordinary factory and mill buildings, and in offices by the use of translucent sun shades or awnings.

Tempering the Light.—The light due to the sunshine on such shades and awnings will be as bright as ordinary skylight if the shade is well chosen, and the ribbed

glass will be still brighter. If the windows are large, the illumination is likely to be too great near the windows, as previously pointed out, and it must be reduced. This should not be done, however, by pulling down an opaque shade over the top of the windows, because the top portion of the window is the part that is particularly needed to give light to the interior of the room. The better scheme is to employ an opaque shade which should be raised from the bottom of the window. This will reduce the illumination near the window without affecting it over the interior of the room to any marked degree.

Bench Locations.—Fig. 2 shows how benches are commonly located with respect to windows, so that the light received on the work may be most satisfactory. This sets a certain limitation upon the possible arrangement of the work over the floor space, depend-

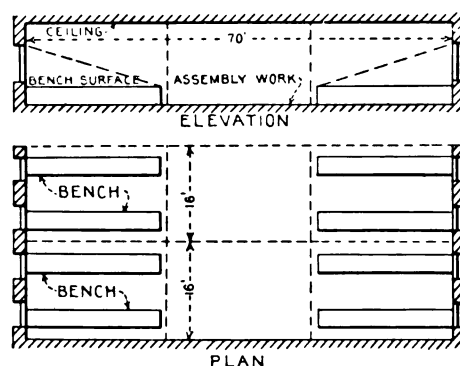


FIG. 2.—DIAGRAM SHOWING BENCHES LOCATED WITH RESPECT TO THE WINDOWS SO AS TO RECEIVE THE NATURAL LIGHT ADVANTAGEOUSLY.

ing on the way the daylight is furnished to the floor area. This limitation can be eliminated almost completely in the case of artificial light through a uniform distribution of lamps overhead. This statement applies to those cases where natural light is transmitted through side windows, and includes a feature specially noticeable in buildings of more than one story. In contrast, the work may be arranged almost independently of the natural light in buildings where the natural light is furnished by overhead windows or through the means of saw-tooth construction.

Window Glasses.—Both translucent and clear glass are employed for factory and mill windows. There is a slight reduction in the transmitted light through ordinary translucent wire glass, but it is often required by insurance regulations for a reduction in the fire risk where a given building is located in close proximity to other buildings. Wire glass is also used quite generally with steel window frames, here being an added protection from the standpoint of fire risk. Wire glass may be obtained in clear form, but its expense in con-

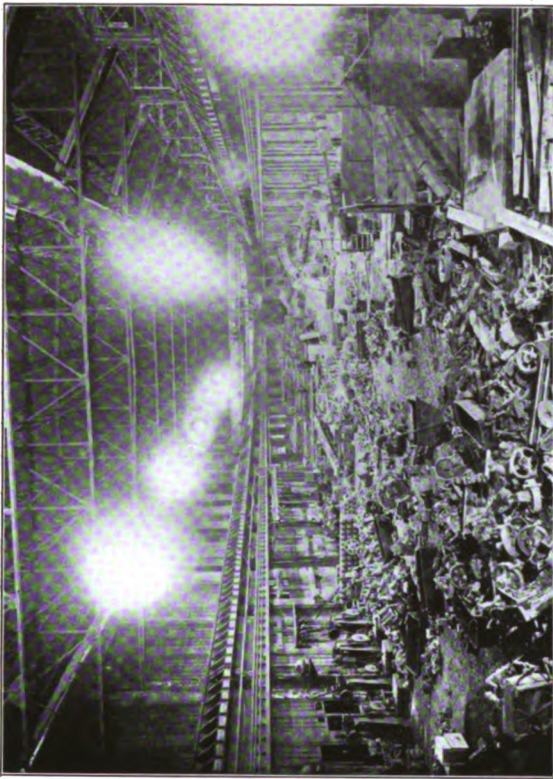


FIG. 12.—HIGH SECTION, SHOWING A SYSTEM OF MERCURY-VAPOR LAMPS. NOTE THE EXCELLENT DISTRIBUTION OF LIGHT OVER THE FLOOR AREA.



FIG. 14.—EXAMPLE OF GOOD TUNGSTEN LIGHTING WITH METAL REFLECTORS. NOTE THE ROW OF LAMPS NEAR THE CEILING FOR PRODUCING GENERAL ILLUMINATION. THIS IS KNOWN AS COMBINED GENERAL AND LOCALIZED ILLUMINATION. COMPARE WITH FIG. 13.

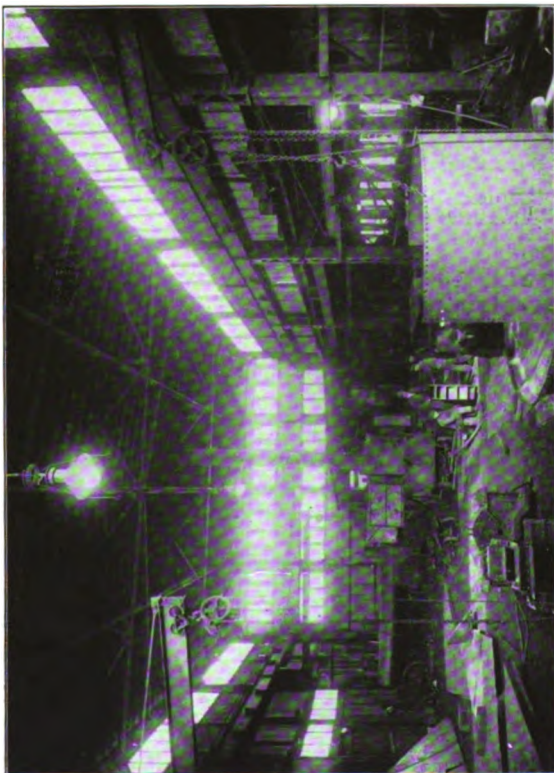


FIG. 11.—DAY VIEW OF RELATIVELY HIGH SECTION, SHOWING A SYSTEM OF GAS LIGHTING.



FIG. 13.—EXCESSIVELY BAD LIGHTING. BARE LAMPS PRODUCE A GLARE WHICH IS HARMFUL AND RENDERS THE ILLUMINATION VERY INEFFECTIVE. COMPARE WITH FIG. 14.

trast to the translucent form is such as ordinarily to prohibit its use for industrial purposes.

Wire Glass.—Wire glass, also known as ribbed glass, should be used and is advocated for practically all factory and mill windows where prisms are not required. Wires of rather open mesh cause so little reduction in light as to warrant no mention of this feature. Special care should be taken to get such glass as is smooth both on the flat side and on the ribbed side to facilitate cleaning. Wire or ribbed glass gives better diffusion than plain glass.

Prism Glass.—Where the sky outside of the windows is obstructed by buildings, prism glass is recommended if the room is deep. Different kinds of prisms cannot be used to advantage interchangeably. The amount of prism glass required in any case depends much upon the surroundings, and to obtain excellent results, of which such glass is capable, it must be used intelligently.

Skylights.—Skylights are sometimes installed in long, narrow, continuous strips in a sloping roof. The ribs of the ribbed glass are generally so arranged that it is convenient to make them at right angles to the length of the strips. The result is that the sunshine is diffused by the ribs over a narrow area parallel to the strip of skylight, thus lighting one part of the room much more brilliantly than the remainder. If the ribs are installed to run parallel to the strips, they will give a much more general distribution of the sunlight. In the foregoing, the word *strip* refers to the long belt of skylight and not to the individual sheet of glass. Ribbed glass in vertical windows should generally be placed with the ribs horizontal. They thus roughly fulfill some of the functions of prisms.

Dirt Accumulations.—While translucent wire or ribbed glass reduces the amount of light transmitted through the windows, the roughness of the outside surface of such glass often causes accumulations of dust and dirt, which are more to blame for the reduction of transmitted light in some cases than the translucent nature of the glass itself. Remedies of this difficulty are to secure smooth glass and to resort to frequent cleaning.

Wire Glass as a Safeguard.—Wire glass for skylights is, of course, a practical necessity as a safeguard against accidents due to accidental breakage of the glass or due to objects falling on top of the glass.

Calculations for Natural Light.—In certain typical localities, the average brightness of the sky during business hours is about 250 candles per square foot. This is probably a fair average value for the entire United States. The lower or minimum value of sky brightness, excluding particularly stormy days, may

be taken as about 100 candles per square foot. Allowing for a reduction of 25 per cent. for losses in the windows themselves, the brightness of the sky as seen through a window becomes equal to a minimum of say 75 candles per square foot in any directions from which the sky can be seen through the windows. This brightness value if multiplied by the part of the window area through which the sky is visible from a given point in the work space gives the available candlepower through the window in question, and this candlepower is then divided by the square of the distance between the given point and the window to obtain the foot-candle intensity of the illumination at the given point.

Method Illustrated.—To illustrate this method, consider a hallway 40 feet long, lighted by a window 5 feet by 5 feet at one end, with the sky visible from the darker end of the hall through the upper half of the window only. The illumination at the dark end of the hall will then be equal to:

$$5 \times 5 \times 0.5 \times \frac{75}{1,600} = 0.58 \text{ foot-candles,}$$

under the assumed window brightness of 75 candles per square foot. The 1,600 in this calculation results from the square of 40 feet, the length of the hall, or, in other words, the distance from the point considered to the window; and the factor 0.5 takes into account the fact that the sky is visible through only one half of the window area from the point considered.

Checking the Intensity.—The intensity is not sufficient at this darkest part of the hall, since the requirements of Article I of the Code proper call for three times the minimum values given in Article V, and the minimum value given in Article V for passageways is 0.25. Three times this value is 0.75, which is somewhat greater than the value found in this calculation. The window area must therefore be increased in size by about 50 per cent., or, if this is impossible or impracticable, the hallway must be provided with artificial light at those points where the natural light falls below the requirement.

Calculation for a Skylight.—As another illustration, assume that fine manufacturing work is to be performed under a skylight 20 feet above the work. If the brightness is assumed to be 75 candles per square foot, as before, the minimum intensity must be 3×3.5 foot-candles; that is, 10.5 foot-candles, based on the requirements of Article I of the Code. The window area must then equal:

$$10.5 \times \frac{400}{75} = 56 \text{ sq. ft.}$$

Part of Window Area to Consider.—It is important in estimating the illumination of any work-room to consider only that portion of the window area through which clear sky is visible, provided the window is equipped with ordinary clear glass.

Sunshine Not Desirable.—In all the work of providing natural light, it should be kept in mind that direct sunshine in itself, from the illumination standpoint, but irrespective of sanitary conditions, is not wanted. The idea that sunshine is the important item is a common but an erroneous impression. For example, in saw-tooth construction, the windows do not face the south to get all the sunshine possible, but they face the north to exclude the sunshine. Ordinary windows, on the other hand, face all directions, because not enough light can be distributed to interiors from north windows alone. Windows on the other than north fronts admit sunshine, to be sure, and this makes sun shades and awnings necessary to exclude the excessive brightness.

SECTION II. VALUE OF ADEQUATE ILLUMINATION.—Factory and mill owners are concerned in the matter of securing the largest output for a given manufacturing expense. An improved machine tool capable of increasing the product for given labor costs is most attractive, provided its first cost is within returnable limits out of the larger profits. Improved small tools, better methods of handling material, adequate crane service, fire protection, good shop floors, accurate and efficient time-keeping methods, and similar items, vitally concern the shop manager; money is expended to realize excellence in these features because they afford increased economies and protection, thus resulting in a higher efficiency of the plant.

Energy Consumption a Minor Item.—Many arguments leading to the sale of gas and electric lamps for use in factory and mill buildings are based on reducing the lamp operation cost by substituting a new for an older system. Arguments of this kind are of value, however, only when such a reduction in operation cost can be effected without sacrifice in the adequacy of the illumination. It would be a poor policy, in the extreme, to argue a saving in energy consumption by the substitution of one type of lamp for another on a basis of equal candle-power in both old and new systems.

Effect of Good Light on Production.—Arguments of a convincing nature, which insure to the factory or mill manager an increased output through improved illumination service, are of importance and even greater at times than reductions in the cost of illumination for the same quantities of light. In view of the fact that resulting advantages of superior illumination on increased output are apt greatly to exceed economies in operation cost as regards the lighting system, it is a distinct advantage to

direct and hold the attention on the former rather than on the latter. This statement will be more apparent when interpreted into definite items, as follows:

Advantages of Good Light.—While the necessity of good natural and artificial light is so evident that a list of its effects may seem commonplace, these same effects are of such great importance in their relation to factory and mill management that they are well worth careful attention. The effects of good light, both natural and artificial, and of bright and cheerful interior surroundings, include the following items:

1. Reduction of accidents.
2. Greater accuracy in workmanship.
3. Increased production for the same labor cost.
4. Less eye strain.
5. Promote better working and living conditions.
6. Greater contentment of the workmen.
7. More order and neatness in the plant.
8. Supervision of the men made easier.

In this list it will be noted that items 4, 5, 6, 7, and 8 all have a bearing on accident prevention.

Interpreting the Advantages of Good Light.—While the major consideration in the eyes of the factory or mill owner is undoubtedly and quite naturally the money value of good light in the larger return of both quantity and quality of work which may result from the installation of a superior as compared with an inferior lighting system, it should be noted that it is very difficult to interpret into dollars and cents the value of good light made possible by such returns. This difficulty is due to the necessity of keeping all conditions in a factory or mill section absolutely constant while varying the amount of illumination from poor to good conditions, in an effort to determine the output and its dependency on the lighting facilities. As accurate data becomes available, giving the increases in production for certain specific improvements in artificial lighting, it will doubtless prove helpful to a proper interpretation of adequate light and its worth to any plant.

The eight foregoing points are emphasized as forming the most important features in the problem of good lighting. Although difficult to interpret into money values, and somewhat intangible, they are indisputable arguments in favor of the best available illumination from the standpoint of the factory or mill owner.

Practical Example.—Continuing from the manufacturer's point of view, it may be said that certain assumptions as to energy cost, cleaning, interest, and depreciation show that the annual operation and maintenance cost for the illumination of a typical shop bay of 640 square feet area may be taken at \$50. If five workmen are employed in such a bay at an average wage of, say, 25 cents per hour, the gross wages of the men in such a bay, plus the

cost of superintendence and indirect shop expense, may equal from \$5,000 to \$7,000 per annum. In a case of this kind, therefore, the lighting will cost from 7/10 to 1 per cent. of the wages, or the equivalent of less than 4 to 6 minutes per day. We may roughly say that a poor lighting system will cost at least one-half this amount (sometimes even more through the use of inefficient lamps and a poor arrangement of lamps), or the equivalent of, say, 2 to 3 minutes per day. Nearly all factories and mills have at least some artificial light; hence, in general, if good light enables a man to do better or more work to the extent of from 2 to 3 minutes per day, the installation of good lighting will easily pay for the difference between good and bad light, through the time saved for the workmen.

Actual Losses.—Superintendents have said in actual instances that, due to poor light, their workmen have lost much time, sometimes as much as from one to two hours per day, or certain days. If good light will add an average of, say, one-half an hour per day to the output, these 30 additional effective minutes represent an increase in output of 5 per cent., brought about through an expenditure equal to 1/2 of 1 per cent. of the wages for improved lighting, or a saving equal to ten times the expense.

Safety.—While these features are of special interest in the eyes of the manufacturer, the principal item to consider, perhaps, from the legislative side of the question, is the necessity of an act or acts to provide employees of workshops with proper and sufficient illumination from the standpoint of safety. The legal aspect of the safety question in its relation to illumination in factory and mill buildings is a topic of unusual importance.

SECTION III. OLD AND NEW LAMPS.—The inadequate means available for illumination by artificial methods in the past have contributed to the slowness of an appreciation of the features of artificial light which influence the working efficiency of the eye. Open flame gas burners, carbon incandescent and arc lamps, practically the only illuminants available ten years or so ago, play but a small part in the present approved methods of factory and mill lighting.

New Lamps.—The large variety of comparatively new lamps available for factory and mill lighting includes the mercury vapor, metallized filament, tungsten, gas-filled tungsten, metallic flame or magnetic arc, the flame carbon arc, the quartz mercury vapor, and various types of gas arc lamps. Remarkable improvements have thus been made in both the electric and gas lighting fields, the same general rules of applying the lamps covering both of these fields. Possibilities in factory and mill lighting are now attainable which, before the introduction

of these new lamps, were either unthought of or impossible. Consideration of the eye as a delicate organ, together with the new ideas of the items which affect its comfort and efficiency, have resulted in establishing certain principles in illumination work, and have directed attention naturally and in a growing manner to the proper use and application of these new lamps.

SECTION IV. EFFECTS ON FACTORY AND MILL LIGHTING PRODUCED BY MODERN LAMPS.—With the introduction of these new gas and electric lamps, broader possibilities have been presented in factory and mill lighting. The use of units of sizes adapted to the purposes allows results which it has been hitherto impossible to obtain satisfactorily, either by the arc lamp, carbon filament or open-flame gas burner formerly available.

New Possibilities.—It is evident that the introduction of the many new lamps has made possible what may be termed a new era in industrial illumination, a distinctive feature of which is the scientific installation of the lighting units, suiting each to the location and class of work for which it is best adapted. Before the availability in recent years of medium-sized gas and electric units the choice of the size of unit for a given location was often no choice at all. In many cases, due to small clearance between cranes and ceilings, or other conditions making is necessary to mount the lamps very high above the floor, but one size or type of unit was available, the carbon filament or open-flame gas burner in the former, and the arc lamp in the latter case.

Low Ceilings.—For low ceilings, up to 18 feet, the use either of carbon filament, open-flame gas burner, or arc lamps resulted usually in anything but uniform light over the working plane, and often produced merely a low general light which was practically useless for the individual machine. In such instances, individual lamps had to be placed over and close to the machines. With this arrangement, relatively small areas are lighted by each lamp, and the metal shades usually employed serve only to accentuate the "spot lighting" effect. Such a form of illumination for factory and mill work is unsatisfactory and inefficient, but, as stated, was in the past, in many cases, the only available scheme. *The absence of lamps of the proper size is no longer an excuse for the existence of such conditions in industrial plants.*

SECTION V. GENERAL REQUIREMENTS OF ARTIFICIAL LIGHTING.—The following requirements for factory and mill lighting are made all the more important by the peculiar limitations and the wide variety of conditions to be found in factory and mill buildings and in factory and mill work:

1. Sufficient illumination should usually be provided for each workman irrespective of his position on the floor space.

2. The lamps should be installed and selected so as to avoid eye strain to the workmen.

3. The lamps should be operated from sources of supply which will insure reliable illumination results, particularly on account of the demoralizing effect produced by intermittent service, just when the light may be most needed.

4. Adequate illumination should be provided from overhead lamps, so that sharp shadows may be prevented as much as possible, and in such measure that individual lamps close to the work may be unnecessary except in special cases.

5. The type and size of lamp should be adapted to the particular ceiling height and class of work in question.

6. In addition to the illumination provided by overhead lamps, individual lamps should be placed close to the work if they are absolutely necessary in the eyes of a lighting expert, and in such cases the lamps should be provided with suitable opaque reflectors.

These requirements may now be met by means of the new types of gas and electric lamps, one type of which can usually be found for practically each factory and mill location, specially adapted to the general physical conditions of the location as typified by the clearance between cranes and ceiling and other similar items.

SECTION VI. OVERHEAD AND SPECIFIC METHODS OF ARTIFICIAL LIGHTING.—Factory and mill lighting may be classified under two general divisions: first, distributed illumination furnished from lamps mounted overhead; and, second, specific illumination furnished by individual lamps located close to the work. For practical purposes this classification is sufficient. In numerous cases a combination of these two methods becomes necessary.

Mounting the Lamps High.—Where the lamps are high enough to be out of the line of ordinary vision, and are of a size and so spaced as to furnish illumination at any position of the floor where work may be carried on, the system is referred to as the *overhead method* of lighting. This method has many advantages. Its general adoption, which has been somewhat slow, has increased with the appearance of the many new types of lamps and with the growing appreciation of the value of good lighting.

Where a small amount of general or overhead lighting is coupled with specific lighting from individual lamps, a large part of the floor space in many shops is in relative darkness, and much dependence must be placed on the hand lamps close to the work. The small number of overhead lamps generally used in such cases furnishes merely a small amount of additional illumination over the floor space which is not sufficient to be of much value. How-

ever, where sufficient intensity is provided by general illumination, this is often a very effective means of lighting a large work-room.

Low Ceilings.—Locations with low ceilings, until recently, have been lighted by the individual hand lamp method, because the old carbon filament lamps, being of low candlepower, could not well be used close to the ceiling, while the old type of arc lamp was often impracticable, due to its large physical size, as well as its relatively high candlepower. This statement is subject to some modification, because low candlepower units have sometimes been used in clusters for low ceilings as a compromise between a single small or a single large unit, this scheme being, however, usually insufficient and unsatisfactory in comparison with modern methods of lighting. In a particular manner, therefore, suitable illumination has been difficult with low ceilings.

New types of gas and electric lamps have a range of candlepower from very low to very high values, and the overhead system with the elimination of individual lamps is thus possible; in other words, a size of gas or electric lamp may now be selected from a large available list of sizes for nearly every factory or mill condition.

SECTION VII. VARIOUS LOCATIONS ILLUSTRATED.*—Figs. 3 to 12 inclusive are given to indicate how the problem of adequate illumination has been solved in a number of actual instances, and the following notes apply to some of the considerations involved.

There are two main items to consider in deciding for or against high candlepower lamps for the factory or mill. First, how high are the lamps to be mounted; and, second, will the light at any given point on the machines or other operations be satisfactory if it comes from a few lamps, or should it come from many sources? If the ceiling or overhead construction is under 16 feet, lamps of high candlepower can hardly be used in sufficient numbers to produce uniform illumination over the floor space. If they are to be mounted at a height between 16 and 25 feet, it is largely a question of whether light from a relatively few lamps will produce satisfactory results. For mounting heights over 25 feet, lamps of high candlepower possess some advantages, chief of which is their large volume of light for given energy consumed, always provided the light is effectively directed towards the floor.

Three Groupings.—These three groupings by mounting heights are conveniently shown in Figs. 15, 16, 17 and 18. In Fig. 15 a single shop bay with a ceiling height of 12 feet is shown as typical of the first grouping. The

* Figs. 3 to 12 inclusive are, in general, arranged in the order of their mounting heights. The low mounting heights are shown in the earlier illustrations and the higher mountings in the later views.

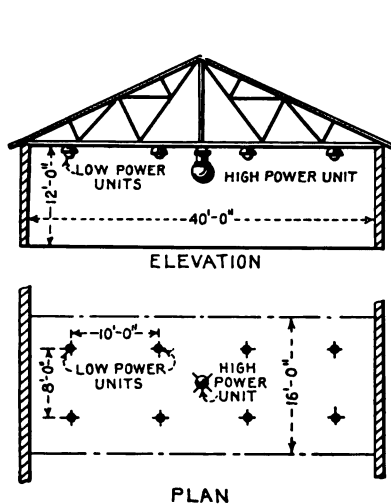


FIG. 15.—DIAGRAM SHOWING ALTERNATE SCHEMES FOR LIGHTING A LOW FACTORY SECTION. THIS CONTRASTS THE USE OF LARGE AND SMALL LAMPS FOR A MOUNTING HEIGHT OF 12 FEET.

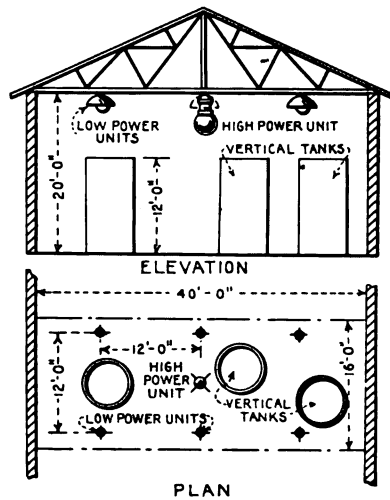


FIG. 16.—DIAGRAM CONTRASTING THE USE OF LARGE AND MEDIUM SIZE LAMPS FOR MOUNTING HEIGHT OF 20 FEET.

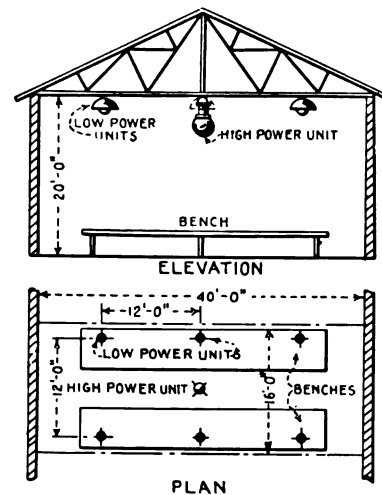


FIG. 17.—DIAGRAM OF SAME FACTORY SPACE SHOWN IN FIG. 16, BUT WITH A DIFFERENT CLASS OF WORK. THIS VIEW CONTRASTS THE USE OF LARGE AND MEDIUM SIZED LAMPS FOR A 20-FOOT MOUNTING.

single high candlepower lamp furnishes approximately the same amount of light to the machines as do the eight small lamps. Note, however, that the illumination from the large lamp is not nearly as uniform as that from the small lamps, although the spacing of both the small and the large lamps as represented in this illustration is typical of many actual installations. Note also that the shadows cast by the large lamp at certain portions of the floor space must be so marked as to make the illumination it furnishes very inferior in this respect to the illumination from the smaller lamps, because of their larger number.

Here, if the number of large lamps for the given floor area be increased in an endeavor to make the illumination more uniform and to reduce the shadows, the expense, as compared with that for smaller lamps, makes the large lamps a very unfavorable proposition. These two features are the basis for stating that in general large lamps are not desirable for mounting under 16 feet, and an analysis of conditions, together with a careful and unbiased comparison with the illumination produced by smaller lamps, will nearly always bear out this conclusion.

Second Grouping.—In Fig. 16 a 20-foot ceiling has been selected as typical of the second grouping, a single shop bay being shown. Here the work is assumed to be rough assembly, mostly on horizontal surfaces, and the single high candlepower lamp, besides giving more nearly uniform illumination, because the light is distributed more broadly, due to the increased height, is correspondingly more satisfactory as to shadows produced by the large lamp in the preceding illustration (Fig. 15),

on account of the improved direction in which much of the light reaches the work. In this case the arrangement of both large and small lamps is typical of many existing installations.

In Fig. 17, however, although the height is the same as in Fig. 16, the work is quite different, being conducted on the inside of large vertical tanks. It would obviously be impossible to perform this work by the light from the single large lamp as well as with that from the larger number of medium-sized lamps, even if the actual amount of light from each was the same, on account of the poor direction of the light at certain positions of the work from a single unit in such a case. The medium-sized lamps furnish approximately the same quantity of light, and yet, no matter where the tanks may be placed, they will receive considerable light from the medium-sized lamps directly over or nearly over them, at least far more than is apt to reach them from a single unit in every other bay (the assumed arrangement of the large lamps).

For this second grouping of mounting heights, then, the large lamp may or may not be adapted, depending on whether the reduction of shadows is of much importance, as is the case in Fig. 17. The large lamp is, however, more likely to be satisfactory here than in the first case (Fig. 15), because of the better distribution of the light, due to the higher mounting, a fact made evident in Figs. 15 and 17 on account of the decreased number of small lamps and the increase in their size made possible in Fig. 17 as compared with Fig. 15, where the mounting is lower. By the same line of argument it can be shown that for higher mountings large lamps are still more likely to prove satisfactory. In Fig. 17 the number of large lamps might have been increased for

the given floor area, but to have done so would mean that the cost for the lamps themselves and for the energy and upkeep to maintain them would be excessive in comparison with the smaller types of lamps.

Third Grouping.—In Fig. 18 the third grouping of mounting heights is shown with the lamps about 50 feet above the floor. In this illustration the distribution of the light from the large lamps will be far more satisfactory both for flat and tall work than in the two preceding cases. It will be noted further that the increased height of the lamp causes the light to fall in such directions as to evenly distribute it over the entire floor space taken care of by this one lamp in much better shape than for the lower mounting heights. (See also Figs. 19 to 21 inclusive.)

SECTION VIII. LIGHTING CIRCUITS FOR ELECTRIC LAMPS AND SUPPLY MAINS FOR GAS LAMPS.—The question of lighting circuits is mentioned here with particular reference to factory and mill conditions, where motor loads are apt to be large in comparison to the energy consumption of electric lamps which are in service. In some cases the proportion of motor load to lighting load is in the ratio of 10 to 1, in others 7 to 1, and so on, and the varying demands on the circuits by motors may greatly affect the lamps. Hence it is important to maintain strictly separate supply circuits for the lamps in order to avoid varying voltage, which is apt to result if the motors are connected to the same circuits with the lamps.

Constant Voltage.—In addition to the superior illumination resulting from lamps supplied from constant voltage mains, some types operate with longer life or very much better mechanically when supplied with constant voltage than otherwise. These features will therefore generally more than offset the somewhat greater cost of maintaining separate circuits for each class of service. In like manner and for similar reasons, it is advisable to place gas lamps on supply lines separate from those delivering gas for power purposes.

SECTION IX. CONTROL OF LAMPS AND ARRANGEMENT OF SWITCHES.—The control of lamps in factory and mill lighting is important in all cases, but specially so where a large number of lamps is used in preference to a small number for a given floor area. For example, where an overhead system of tungsten lamps of small size is used, a large number will, of course, be necessary for a given floor area, and in such cases the number of control circuits may at times seem excessive when planned out for sufficient flexibility of operation. Such circuits, however, in rendering the system more flexible, will be more than

paid for by the saving in energy and maintenance due to the turning out of lamps not needed in certain sections of the factory or mill, provided the number of hours per day during which the lamps are used on the average is relatively large, and the differences in daylight intensities over the floor area is also relatively large.

Control Parallel to Windows.—The lamps most distant from the windows will usually be required at times when the natural light near the windows is entirely adequate, thus making it an advantage to arrange the groups of lamps in circuits parallel to the windows. The advantage of this method is further apparent when it is considered that if the lamps are controlled in rows perpendicular to the windows, all lamps in a row will necessarily be on at one time, while a portion only may be required.

Practical Case.—The foregoing statement may be developed into a definite proposition. Thus, to install a single switch may involve, say, \$5 as its first cost. If ten lamps are to be controlled from a single switch, these ten lamps must obviously either all be turned off at a time or all turned on at a time. An additional switch at a cost of \$5 will permit either half of these ten lamps being turned off if not required at certain times when the remaining five are needed. This extra switch may or may not be an economy. Consider, for example, the case where these five lamps are of the 60-watt tungsten type, and that they are turned off by the extra switch on an average of one-half an hour per day while the others are needed, or *vice versa*. In a year's time the energy saved at 1 cent per kilowatt-hour will amount to perhaps 50 cents. At this rate it will require ten years for the energy saved to pay for the first cost of the extra switch. This would not be considered a distinct economy. If, however, the energy cost be greater, and more nearly the average under actual conditions, or if the number of hours per day during which a portion only of the lamps will not be used be greater, then these values will be correspondingly modified.

Locating Switches and Controls.—In locating switches or controls in factory and mill aisles, care should be exercised to arrange them systematically; that is, on columns situated on the same side of the aisle and on the same relative side of each column. This plan materially simplifies the finding of switches or controls by those responsible for turning on and off the lamps, and is particularly important where a given floor space is illuminated by a large number of small or medium-sized lamps distributed uniformly over the ceiling area, a feature which is usually accompanied by the use of a relatively large number of switches or controls.

(Continued in September issue)

SOME RANDOM OBSERVATIONS ON THE RELATION OF THE JUNIOR MEMBER TO THE ENGINEERS' CLUB*

S M. SWAAB, Past President

THE most important thing about the Juniors is that if they live long enough they will grow into Active membership.

During their novitiate they naturally become acquainted with the aims, desires, hopes, and aspirations of the Club, and therefore, because of their knowledge of its traditions, they are better able to enter into the spirit of the organization and to understand the duties imposed by membership than an outsider of their own years and of like professional experience. The Juniors are the source to which the parent body looks for its greatest stimulus to activity, or, as Wordsworth puts it, "The child is father of the man."

An occasional infusion of new blood into the Club, even in small doses, is required to maintain the bodily strength and mental vigor of that organization. Many organizations stagnate because they lack this, and there is no gainsaying the fact that it is absolutely necessary to keep us abreast of the times.

Modesty is the natural instinct of a real gentleman. Engineers are usually too modest, some of them to a superlative degree. Modesty and advancement do not always go hand in hand. Success in this world is to the "physically and mentally fit," and moral attributes often have too little weight in the race. To attain the meed of happiness is our ultimate aim in life, and whether it is toward the zenith or the nadir, each must determine for himself. The engineer has had, and still labors under, certain handicaps he were better rid of. Professor Haupt, the first president of this Club, used to say that the engineer usually could be distinguished by the style and quality of his raiment, or, rather, by the lack of it, and also by his imperfect language.

The achievements of engineers have often been sung from the housetops, and they have been hailed as leaders in thought and deed, but, in spite of their numerous high attainments, few engineers possess the faculty of being able to express their thoughts while on their feet in a manner sufficiently lucid to impress an audience. Of course, engineers are usually concerned with matters of rather serious nature, matters that concern the pocketbook. The average man may be willing to trust his liberty to an unpretentious lawyer and his life to a young and inexperienced physician, but when it comes to spending money he is usually

more careful in the selection of his advisers. The lawyer and doctor appeal usually through the medium of publicity.

Engineers are usually men of few words, and extemporaneous speaking has not been considered in their line. What is particularly desirable is that the professional engineer, among his other attainments, should be able to express himself forcibly and to the point when occasion requires without extended previous preparation. Public speaking is a fine art in which all of us should be more or less proficient, and a knowledge of it is worthy of our most ardent efforts; and the Junior meetings seem to be the proper place where this art can best be developed. If nothing else than this can be accomplished by the Juniors for the coming engineers of the city of Philadelphia, I do not hesitate to say that they deserve to be congratulated on this achievement.

An engineer's education should be rounded out by a study of the non-mathematical sciences for the broadening effect which they possess, and a post-graduate course in such studies could be conducted in no place better than in the meetings of the Juniors. Mathematics and its allied branches and the classics were formerly taught, because a knowledge of them was thought to be broadening, but the consensus of opinion of educators at this day is quite contrary, or at least many of them do not hold this view. Mathematics, I believe, is taught because of its utility as a tool to be used in the fashioning of the work in hand.

Clear and accurate thinking and expression are faculties which can and should be developed. Read the specifications prepared by some of our acknowledged good engineers and there is often room for difference of opinion as to what they actually mean. In some instances we would be almost forced to believe that "language was devised to conceal thought," as has been aptly stated by some one. In a certain case in a local court, in which an interpretation of the specifications was involved, the learned trial Judge, at that time the acknowledged leader among the Judiciary of this county, after looking over the specifications passed them on to the foreman of the jury with the trenchant remark, "If you can make anything out of them, it is more than I can."

Develop a knowledge of the sense of proportion and be able to see a subject as a whole and appreciate bigness as a factor in things, and do not rightfully

* Address delivered at the Junior dinner, May 28, 1917.

(Continued on Page 388)

ENGINEERS' CLUB OF PHILADELPHIA

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S. M. SNEDEKER

EDITORIAL

THE question of the proper relation of our Junior members to the Club has been under recent discussion. Considerable thought has been given to the matter, with the view of organizing the Junior Section to take a definite part in the Club's activities and so become a more important factor in the Club's general development.

The only references in the By-Laws to Junior members are in Article I and Article 7, and may be referred to here:

Article 1, Section 1.—The Club shall consist of Junior members, resident and non-resident.

Article 1, Section 4.—A Junior member shall be at least twenty-one years of age and less than twenty-seven years of age, and shall be one who by scientific or technical training or practical experience is qualified to cooperate in the advancement of engineering. A Junior member shall not be entitled to vote nor to hold office, and, if found eligible by the Committee on Membership, shall be transferred to Active membership at the beginning of the fiscal year next succeeding the twenty-seventh anniversary of his birth. The total number of Junior members shall not at any time exceed ten per cent. of the total membership.

Article 7, Section 2.—The membership dues shall be payable annually in advance, and shall be as follows: Resident Juniors, ten dollars; non-resident Juniors, ten dollars.

At present there are ninety-four Junior members, tabulated as to ages as follows:

Ages, years	21	22	23	24	25	26	27
Number	5	7	25	46	11	—	—

It may be interesting also to know the distribution as graduates from various high schools and colleges:

American School of Correspondence	1	Massachusetts Institute of Technology	2
Ambler High School	1	Mount St. Mary's Engineering College	1
Cornell University	2	Northeast High School (Philadelphia)	2
College of City of New York	1	Pennsylvania State College	3
Central Manual High School (Philadelphia)	2	Swarthmore College	1
Drexel Institute	5	Syracuse University	1
Haverford College	1	Temple University	3
International Correspondence School	2	University of Pennsylvania	52
Lafayette College	2	Williamson School	2
Lehigh University	2	Non-graduates	8
Total			94

Here is a band of young engineers of average age of twenty-four years, the larger number graduates of representative high schools, colleges and universities, worthy the best effort and thought of the Club, for the purpose not only of developing them for use in the future active membership, but also for the highest service they may be to the community. These young men, enthusiastically interested in the activities of the Club, though but five per cent. of our total membership, earnestly desire to have their own organization—officers and committees.

At present the Juniors are meeting among themselves at regular intervals and are under the surveillance of a Senior member and the Board of Directors. At their annual meeting and dinner held at the Club House on May 28, 1917, a committee appointed to present a request to the Board made a report asking for separate organization for meetings, with their own officers, Executive Committee and Papers Committee.

Such organization could be had with Directors or active members *ex-officio* members of all such committees, to retain the control under the direction of the Board. At the dinner above mentioned Mr. Swaab and Doctor Boehm outlined valuable suggestions as to the relations of the Junior members to the Club, how such relations were reciprocal between the Active and the Junior members; how a proper organization would develop all the possibilities of the Junior and ultimately qualify him in all the essentials of Senior membership.

The statistics above shown indicate that about ten per cent. of the Junior members automatically will be transferred to Active membership within two years, and that three years will show almost a fifty per cent. decrease in such membership, also by transfer; so that to maintain the Junior unit as an efficient and active one, as well as one of sufficient size, accessions must be had as a continuing process. A Junior committee on increase of membership would find a large and open field of endeavor worthy its best efforts to increase their numbers for more efficient work among themselves, and to keep their ranks filled as a result of the regular depletion at the age limit, and as mutually advantageous to both the Club and the Junior organization.

COMMITTEE ON PAPERS

LEWIS H. KENNEY, CHAIRMAN

REGULAR MEETINGS

The Committee, in view of the probable extensions to the Club House, and the uncertainty as to the date when the auditorium will be available for Club meetings, has arranged to hold meetings at Witherspoon Hall on the following dates:

Tuesday, September 18, 1917
Tuesday, October 16, 1917
Tuesday, November 20, 1917
Wednesday, December 19, 1917
Wednesday, January 16, 1918

Announcement of the speakers will appear in later issues of the PROCEEDINGS. Joint meetings will be held with our Affiliated Societies in October, November, December, and January.

JUNIOR MEETINGS

The Committee, last year, arranged for a series of meetings for the Junior members.

Arrangements are in progress for a similar series of meetings next year.

Dr. W. M. Boehm, who was Chairman of the Junior meetings last year, will continue in office. On account of the interest manifested by the Juniors in the Junior Prize offered last year, the Committee will again offer the prize, to be governed by the following rules:

I. The competition for the prize shall be restricted to Junior members of the Club.

II. The prize shall be \$50 in cash.

III. The prize shall be awarded to a paper describing an engineering work with which the writer has been directly connected, or it shall record investigations contributing to engineering knowledge, some essential part of which was made by the writer, and contain a rational digest of results. Any mathematical treatment must show immediate adaptability to professional practice. Accuracy of language, excellence of style, and appearance of the paper will be factors in the award.

IV. No paper will be accepted which has previously been submitted for the prize, or which has been published.

V. All papers must be submitted on sheets 8½ by 11 inches.

VI. All papers must be submitted to the Committee on Papers on or before the last day of the Club fiscal year, March 31, 1918.

VII. These rules may be modified by the Committee on Papers.

COMMITTEE ON MEMBERSHIP

D. ROBERT YARNALL, CHAIRMAN

CANDIDATES FOR MEMBERSHIP

Members having knowledge of the candidates are invited to submit to the Committee on Membership before September 10 a confidential expression of opinion as to the eligibility of the candidates; all communications to be addressed, "Chairman of the Committee on Membership, Engineers' Club, Philadelphia," marked "Confidential."

All applications are on file at the Club and can be referred to by any member.

FOR ELECTION TO ACTIVE MEMBERSHIP

JACKSON BEAMER ARMSTRONG

6126 Carpenter St., Philadelphia, Pa.

Superintendent for J. H. Terry & Co.

Proposed by J. H. Costello, E. F. Cobb and John J. Peacock.

WALTER GORDON ARMSTRONG

5217 Wissahickon Ave., Philadelphia, Pa.

Manager, Specialty Department, Edward G. Budd Manufacturing Company.

Proposed by F. J. Ryan and Walter L. Fitzgerald.

HARRY PAUL BARNES

Ambler, Pa.

Assistant to Vice-President and General Manager, Keasbey & Mattison Company.

Proposed by William C. Aichele and H. F. Sanville.

CHARLES CLEES, JR.

5400 Whitby Ave., Philadelphia, Pa.

Manager of Edward Valve and Manufacturing Company, Philadelphia.

Proposed by Frank H. Schaefer, M. C. Gillett and Raymond E. Jones.

EDWIN C. HUBER

2013 Van Buren St., Wilmington, Del.

Cost Accountant, Harrisons, Inc., Philadelphia.

Proposed by Harold L. Miner and Emmett C. Thompson.

CLARENCE ARTHUR LONG

Lewistown, Pa.

Transitman, Driscoll Company, Philadelphia.

Proposed by Walter Loring Webb and C. G. Cope.

HENRY J. PERRY

3500 Gray's Ferry Road, Philadelphia, Pa.

General Manager, Schaeffer Machine Works.

Proposed by Charles F. Schaeffer, Robert T. Aiman and Henry De Huff.

FOR ELECTION TO JUNIOR MEMBERSHIP

GORDON WILLIAM ANDERSON

Sharon Hill, Pa.

Student Engineer, Bell Telephone Company of Pennsylvania.

Proposed by J. W. Van Alst, Jr., and William D. Forster.



SITUATIONS VACANT

WANTED: Civil Engineer—drainage operations; \$200 per month.

Apply Engineers' Club, No. 159-A

POSITIONS WANTED

Superintendent of construction. Eight years' engineering and construction (field and office), including railroad building, highway and sewers. Draftsman. Apply Engineers' Club, No. 157.

Machine designer, experienced on tool machinery and a specialist on large spiral gearing for steam turbine work. Apply Engineers' Club, No. 159.

Power plant supervisor, or efficiency work, desires position. Apply Engineers' Club, No. 160.

COMMITTEE ON COÖPERATION FOR NATIONAL DEFENSE

GEORGE R. HENDERSON, CHAIRMAN

MEMBERS OF ENGINEERS' CLUB WHO HAVE BEEN CALLED INTO SERVICE IN THE ARMY OR NAVY OF THE UNITED STATES AS OF JULY 20, 1917

NAME	RANK	CORPS	LOCATION
ANDERS, D. W.	Captain	Engineers' Officers' Reserve	
ANDREWS, J. H. M.	Major	1st Regiment of Engineers, National Guard	
ASPLUNDTH, E. T.	Captain	Engineers' Officers' Reserve	Belvoir, Va.
BRADFORD, J. S.	Captain	Co. "B," 1st Regt. of Engineers, Nat'l Guard	
BREEN, J. W.	Captain	Engineers' Officers' Reserve	
BROADHEAD, ALEX.		"B" Company, Engineers' Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
BUTLER, E. N.	2nd Lieutenant	Co. "B," 1st Regt. of Engineers, Nat'l Guard	
CACCAVAJO, JOS.		Engineers' Training Camp	Washington, D. C.
CRAMPTON, G. S.	Major	Medical Corps, National Guard	Fort Benjamin Harrison, Ind.
DONNELLY, J. B.	1st Lieutenant	Co. "E," 1st Regt. of Engineers, Nat'l Guard	
ELCOCK, CHAS.	1st Lieutenant	Co. "B," 1st Regt. of Engineers, Nat'l Guard	
FULWEILER, J. E.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
GWILLIAM, MARK R. M.	2nd Lieutenant	21st U. S. Infantry	
HALL, W. A.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
HOLLENBACK, E. E.	Major	1st Pennsylvania Infantry, National Guard	Columbia, Pa.
LAWRENCE, G. E.	Lieutenant J.G.	Naval Coast Defense	Philadelphia Navy Yard
LAWSON, T. W.	Lieutenant	Supply Co., 1st Penna. Infantry, Nat'l Guard	Philadelphia
MCCORD, J. B.	Captain	Ordnance Officers' Reserve	War Department, Washington, D. C.
MYERS, W. T.		Fort Niagara Officers' Training Camp	Fort Niagara, N. Y.
NEWLIN, E. M.		Fort Niagara Officers' Training Camp	Fort Niagara, N. Y.
NIXON-MILLER, W.	Captain	Engineers' Officers' Reserve	Belvoir, Va.
O'CONNOR, C. P.	Captain	Engineers' Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
REED, R. W.	Private	"E" Company, Engineers' Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
RIDGWAY, J. J.		Company 7, Officers' Reserve Training Corps	Fort Niagara, N. Y.
RITCHIE, J. M.	Captain	Quartermaster's Officers' Reserve	Washington, D. C.
SANVILLE, L. F.		Co. "F," 2nd Artillery, Penna. Troops	Philadelphia
SHUSTER, W. H., JR.		Fort Niagara Officers' Training Camp	Fort Niagara, N. Y.
TILLSON, P. E.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
WARFEL, A. C.	2nd Lieutenant	Engineers' Officers' Reserve Corps	
WARFEL, J. P.	Senior Lieut.	U. S. Naval Reserve Force	
WHITE, W. M.	1st Lieutenant	Co. "B," 1st Regt. of Engineers, Nat'l Guard	
WILD, H. J.	Captain	Engineers' Officers' Reserve	Belvoir, Va.
WILSON, L. B.	Private	Company I, 1st Pennsylvania Infantry	Rockville, Pa.
WORTH, J. G.	Captain	Quartermaster's Officers' Reserve	

Important information concerning Signal Corps U. S. Army on Page 389

REQUEST FOR INFORMATION

THE COMMITTEE REQUESTS THAT THE MEMBERS OF THE CLUB INFORM THE COMMITTEE OF THEIR ADMISSION TO THE MILITARY OR NAVAL SERVICE

THE COMMITTEE WOULD ALSO BE PLEASED TO RECEIVE SUGGESTIONS FROM MEMBERS WHO HAVE ENTERED THE SERVICE. PLEASE ADDRESS COMMUNICATIONS TO THE COMMITTEE ON COÖPERATION FOR NATIONAL DEFENSE.



AMERICAN SOCIETY OF MECHANICAL ENGINEERS .: PHILADELPHIA SECTION



LEWIS F. MOODY, Chairman.

JOHN P. MUDD, Secretary Midvale Steel Company, Nicetown, Pa.

THE NEW CHAIRMAN

Lewis F. Moody, recently elected chairman of the Local Section of the American Society of Mechanical Engineers, was born in Philadelphia in 1880. He received his primary education at the Friends' Select School, and later entered the University of Pennsylvania, where he graduated with the degree of B.S. in 1901. In 1902 he received the degree of M.S.



LEWIS F. MOODY

He was instructor in mechanical engineering in

the University from 1902 to 1904, and from 1904 to 1908 he was affiliated with the I. P. Morris Company and was engaged in the designing and testing of hydraulic turbines. In 1908 he was elected assistant professor of mechanical engineering at the Rensselaer Polytechnic Institute, at Troy, N. Y., and later became professor of hydraulic engineering. From 1911 up to the present time he has been consulting engineer for Wm. Cramp & Sons' Ship and Engine Building Company, in the I. P. Morris department of the company.

Mr. Moody is a member of the Sigma Xi and Tau Beta Pi Honorary Fraternities and a member of the Society for the Promotion of Engineering Education. He was formerly vice-president of the Society of Engineers of Eastern New York.

The Patent Office Society is an organization now forming to try to improve the conditions and service of the Patent Office and patent practice. It comprises the great majority of the Law Examiners, the Chiefs of the Examining Divisions, Assistant Examiners, the Examiner of Classification, the Examiner of Interferences and others. Its officers and Executive Committee now are:

W. A. Kinnan, President.
B. N. Norris, Vice President.
W. D. Shoemaker, Secretary.
A. W. Cowles, Treasurer.

Executive Committee

Mann, Coulston, Jewett, Lovett, Porter, Russell, Lightfoot, Savage.

No honorary members have yet been elected.

Circular letters regarding the organization have been sent out to the various Society Secretaries. The new Society has omitted to adopt any regular time or place for meeting, and Mr. Bert Russell, on his own initiative, has framed a set of resolutions, expressing as he sees it the purpose of the Society.

The ideas and intentions of the Society are no doubt very laudable; at the same time, there is a question as to whether or not there is a need for any more scientific and technical societies at the present time. It is very probable and possible that the good work proposed for the new Society could much better have been handled by one of the already organized societies, such as the American Society of Mechanical Engineers, which has already given considerable attention to the matter of patents.

THE AMERICAN UNIFORM BOILER-LAW SOCIETY

FOR THE LEGAL ADOPTION OF THE A. S. M. E. BOILER CODE

BULLETIN No. 9.

WE beg to report to you our activities since our last Bulletin, dated January 8.

A great many of the legislatures in the various states convened in January, and, while we met with some keen disappointments, we feel that the work accomplished is very far-reaching in its results. Our effort has been very largely an educational campaign. All parts of the country, East, West, North, and South, have had attention, and public opinion has been directed toward the effort we are making, and we are quite confident that in states where we failed to get the legislation

through this time at the next meeting of the legislature we will have no trouble in putting the legislation through.

In harmony with our experience, we have in all cases limited our effort to get an Enabling Act through the legislature to create a board to draw rules. We have met with a great deal of opposition in several states because of the fact that we refused to participate in legislation concerning the detail of inspection of boilers. The Boilermakers' Union, under the leadership of Mr. James J. Casey, has been very insistent that only boilermakers be appointed as inspectors, and in many states had this

(Continued on Page 391)

PHILADELPHIA BRIDGES

(Continued from Page 361)

rider to the smokestacks of the locomotives, and the iron work of the old bridge was very much corroded. The old floor consisted of 12-inch iron I-beams laid the long way of the skew, the skew, I think, being about 30 degrees, making the I-beams considerably over 30 feet in length, and although they were only 12 inches deep they carried street paving of from 20 to 24 inches of gravel and stone blocks. The beams deflected about three inches under that dead load, and were much corroded directly over the middle of certain tracks where the railroad traffic ran upgrade. The flanges of the beams were very much reduced in section at these points, but these old iron beams, 12 inches deep, much reduced in section and carrying a very heavy load, deflecting three inches under the dead load, were still carrying eight-wheeled trolley cars, fully loaded, apparently without distress, the observed deflection under the fully loaded trolley cars going over them being about one-half inch only under the live load. The beams had quarter-inch buckle plates on them originally, buckles up. The plates would corrode through in spots, the gravel would fall through the holes thus created on to the cars of the Pennsylvania Railroad, and the railroad people complained. The bridge was finally condemned. There was, however, no money with which to build a new bridge; the two streets using it were very important avenues; there was no other crossing of that railroad between Forty-first and Fifty-second Streets, and it seemed cruel to the public to shut it off. We therefore decided, in view of the slight deflection those beams suffered under street loads, to let ordinary traffic go over it. The bridge remained in service for a year or two longer, until Councils appropriated money and a new bridge was built. In the first plans we made for the new bridge we followed the old custom of using I-beams with buckle plates on them, dished down, and protecting those I-beams with wooden ceilings, which was the practice of that day. The buckle plates were to be three-eighths of an inch thick. It was customary to use three-eighths-inch over railroads, to allow for corrosion. Such plates would weigh 16 pounds per square foot, and would have cost about four cents a pound with their thousands of rivets, making 64 cents per square foot for the buckle plates alone. The wooden ceiling cost, painted three coats inside and outside, about 25 cents per square foot—a total cost of about 90 cents per square foot for buckle plates and protection.

After having the plans made on that design we changed from buckle plates to concrete jack arches between the beams, because the concrete jack arches would take the place of both the buckle plates and the wooden ceiling, and would cost, taking an average of about 12 inches of concrete over the whole area of the floor, only about 30 cents per square foot, saving in the neighborhood of 55 to 60 cents per square foot

over that large area just by the substitution of concrete jack arches, which would at the same time protect the steel beams more completely and more permanently than a wooden ceiling could. Then we found, also, that with the use of concrete jack arches we need not figure each individual beam to carry the whole of the concentrated load. The concentrated load we figure bridge floors for is 20 tons on an axle, 40 tons on two axles 20 feet apart, and, with an axle parallel to a beam which that bridge would be subject to, we determined that we could depend upon the concrete of the floor to arch over a beam as well as between beams, so that the combination of two arches acting over an individual beam would carry to the two adjacent beams three-eighths of an axle load, three-sixteenths to each side. We therefore need figure an individual beam of the floor for only five-eighths of the 20 tons, whereas with the buckled plates, which cannot distribute, we would have to figure each beam of the floor to carry the whole of one axle load. It was not our practice to assume that buckled deck plates, when they were in single buckle pieces, added section to the beams, although they do, no doubt, add to the stiffness and, in reality, to the carrying capacity of the beams. We saved then not only in the cost of the buckled plates and the ceiling, but in the weight of the steel beams themselves. The structure of the bridge was lighter—considerably less steel work in the floor members—and, as I recall it, we saved \$30,000 in the cost of that one bridge by the change from buckled plate irons to concrete jack arches, and we got the protection of the steel work at the same time. That bridge was built about the year 1908, and probably has not cost a cent for repairs.

I have been charged with having a particular predilection for arches, and I was looking in the paper this evening for a bridge that has always been interesting to me, but it was not mentioned. I have been rather disappointed that it has not attracted more attention and the comments of other people. That is a little 82-foot span steel arch over the Chestnut Hill Branch of the Pennsylvania Railroad, on the line of Duval Street, just east of Wayne Avenue. It is a fixed arch; the abutments of it are wide, and there is no provision made for changes of temperature. The bridge must therefore bend at the crown in accommodating the rise and fall due to temperature, and in order that it may do that without harm the crown was made very thin—only six inches in depth. But it is a shapely little bridge, met the particular conditions of the place very well, and was economical. It is a type of bridge which should be available in many places. I resort to the arch wherever it seems to be an advantage. It is pleasing to the eye, and is appreciated by the general public.

Philadelphia has some very interesting bridges. Some of them are particularly fine, especially the one just completed over the Pennsylvania Railroad on the

line of Diamond Street. It is a pleasure to go over such a bridge and see the tasteful design and the excellent workmanship. We have not yet anything very large. Walnut Lane, at the time it was built, was the longest concrete bridge in the world—not merely the longest plain concrete arch, but the longest concrete arch. There were two stone arches in Europe—one at Luxemburg and the other at Grünwald—which were longer in span. Within a year or two after the Walnut Lane Bridge was finished a concrete bridge of similar design was built at Cleveland with 47 feet longer span. It is not, however, so majestic—nor so impressive—as the Walnut Lane Bridge, because it springs right from the water's edge. It is over Rocky River, on the line of Detroit Avenue. It has a rise of arch corresponding to its span, but has not the clear height above the water that the Wissahickon gorge gives to the Walnut Lane span, and therefore, as you stand on the bluff and see the depth below at the same time as the height above, the picture is more impressive than the much longer span at Cleveland. Soon after Cleveland built its Rocky River Bridge, Spokane built a bridge one foot longer—at least started it, though on the first effort it fell down in the process of building. Then the New York State Barge Canal Board designed a bridge of similar type, four feet longer span than the Spokane, or 285 feet, to carry the canal over the Medina ravine; but the plans were changed, a fill was made with a culvert through it, and the great arch was not built. Since then several reinforced concrete arches have been built in Europe and in America, with longer spans, one or two of them in Pittsburgh.

We are probably in sight of a longer bridge in Philadelphia, looking forward to the Delaware River Bridge as a possibility of the future and as being some-

thing very notable. We have the opportunity there to build a long-span bridge. The only scheme that is really worthy, I think, is a long span at a high elevation above the water to clear shipping, and we are considering the possible connection that bridge may have with our rapid-transit plans in the city. It is desirable that at least one rapid-transit line and its connection with the other rapid-transit lines of the city should connect with a bridge across the Delaware to Camden. See what tremendous business the Brooklyn Bridge does in New York, the lines over it carrying people to all parts of Brooklyn and its suburbs without change of cars from New York. Some day a similar arrangement will have to be made in Philadelphia.

As between a tunnel and a bridge for the Delaware River crossing, a tunnel built for street-car lines would not serve for vehicles or pedestrians, and both these classes of traffic demand crossing facilities. To accommodate vehicles and pedestrians an additional tunnel would be required. The building of such a tunnel between Jersey City and New York, under the Hudson River, is now seriously being considered. A commission of engineers seems to favor it, and it may come, but nobody seems to have proposed a tunnel of that class for the East River, where a bridge is undoubtedly practical and feasible, and where there are already five bridges. There is no bridge yet over the North River, although designs and estimates of cost have been made and engineers say that a bridge there is practicable. The Delaware River is a little wider than the East River, and would require a longer span, but there is no question about the practicability of such a bridge. It is a very much more desirable means of communication than a tunnel. You will have to have several tunnels, and soon more money would be spent than the cost of a bridge, with less satisfactory service.

BY MR. GEORGE S. WEBSTER

MR. PRESIDENT, I was very much interested in the paper presented by Mr. Kline, in which he so clearly brings out many of the interesting features of the bridges in Philadelphia. Great advancement has been made in the last twenty or twenty-five years in the type and architecture of bridges in this city. This has not been brought about without a very considerable amount of labor by the engineers and those in charge of obtaining appropriations for the construction of bridges. Thirty years ago Councils objected to appropriating any money for maintenance and very little for construction, and on one occasion, when a plain plate girder bridge with a solid floor and paved deck was built, the Bureau was charged with extravagance, the claim being made that two or three wooden bridges could have been constructed for the price of this one bridge.

Realizing the difficulty of securing appropriations, a campaign of education was started, and through the

annual reports and by colored perspective maps important projects were brought to the attention of the public. In this way the people in the various localities became aware of how developments could be made by a given type of bridge construction, and when the matter came before Councils for action the particular type of bridge recommended by the Department was generally demanded.

One of the first campaigns of this kind that was undertaken in the city was that known as the Pennsylvania Avenue subway, where seventeen grade crossings were abolished by depressing the railroad tracks and carrying the streets over them. I believe that this project would never have been authorized by Councils had there not been prepared in advance a complete perspective view of the entire work, lithograph plans of which were placed on the desk of each Councilman at the time the ordinance was introduced, making it unnecessary to read the text—an exami-

nation of the plan being sufficient to show exactly what was contemplated.

When the Walnut Lane Bridge was constructed colored plans illustrating the advantages of the improvement were prepared in advance; the public was thus educated to the type of bridge best adapted for the locality, and the necessary appropriation was secured. The same methods are now being pursued by the city in bringing to the attention of the public proposed projects for municipal development.

The fact that the architectural features of bridges may be constructed of concrete without great expense has enabled the city to erect bridges of pleasing design—in fact, the construction of reinforced concrete bridges in the United States practically commenced in Philadelphia. The second reinforced concrete bridge built in this country was on the line of Pine Road,

over Pennypack Creek, in the year 1890. This was followed by the building of a concrete bulkhead wall along the Delaware River, between Vine and South Streets; then other bridges were constructed, such as the one at Frankford Avenue over Poquessing Creek, on the line of the Chestnut Hill branch of the Philadelphia and Reading Railway Company, and at many other localities. Each design contained some improvements over former plans, and I have no doubt that those now in charge of the bridge department of the city will continue improving the design and type of bridges each year as appropriations are made.

Fortunately, Councils now recognize the necessity of providing funds for erecting such bridges as are necessary to abolish existing grade crossings and for opening up new public highways where they cross railroads and streams.

A FEW FACTS RELATIVE TO THE GEOLOGY OF PHILADELPHIA PHYSICAL CHARACTER OF MATERIALS ENCOUNTERED IN EXCAVATING, ESPECIALLY FOR SUBWAYS

From Philadelphia Rapid Transit Report

THE original and older portion of Philadelphia lies in a neck of land between the Delaware and Schuylkill rivers. This strip is about two miles in width at its narrowest point, which is along the line of Market Street. Broad Street occupies approximately the summit of the dividing ridge between the two rivers.

North of Market Street this summit of the watersheds moves westerly. The slope towards the Schuylkill River is more rapid than towards the Delaware. The general elevation of all the central part of Philadelphia is moderate, running from 0, or City Datum, which is 2.25 feet above mean high tide in the South, to +39 at City Hall, and only reaching +400 at Chestnut Hill, in the extreme northwest.

The greater part of the area of Philadelphia is covered with a layer of sand and Trenton gravel. The gravel is of the red and yellow varieties and runs in size from a coarse sand to boulder gravel. The thickness of the layer varies from a few feet in the upper parts of the city to 100 feet or more in the southern sections. In South Philadelphia this gravel is overlaid by a bed of alluvial mud of varying thickness and in many places by thick layers of a fine brick clay. The gravel is underlain by rock of the older formation and of very uneven contour, principally of the gneiss or mica type, with a general northerly dip.

In the central business section, Broad and Market Streets, after passing through a top soil of sand and clay good gravel is usually met with at 15 to 20 feet below the street level and continues to about 40 feet. Here it becomes what is known as cemented gravel and is of great supporting power. A pick must be used in removing it. Pockets of quicksand are occasionally encountered in this formation.

Rock is reached a few feet lower. The upper stratum of the rock, especially if near the surface, is

usually rotten and easily loosened. Below the few feet of rotten rock there lies bed rock of gneiss or schist formation to a great depth. In Germantown the rock contains a large amount of mica, while in Frankford it is of a more granitic character. In the northerly sections the rock outcrops at the surface. In the Chestnut Hill and Germantown localities the mixture of mica increases and the rock becomes a modified gneiss or mica schist. In certain quarters it also becomes granitic in structure. At Manayunk and Conshohocken the rock is harder and more steatic, while in Central West Philadelphia it is combined with more hornblende and feldspar. The stratification in all sections is subject to many dislocations and faults, and while the general dip is northerly, it changes to westerly in West Philadelphia.

In general, the rock formation is not water-bearing, but owing to its broken and fissured character large inflows of water from seams in the rock may be encountered in any large rock excavation. In the gravel formation in the central and southern sections of the city the permanent ground water line appears to be at about the elevation of City Datum.

From preliminary borings made at intervals of about 500 feet along North Broad Street an approximate idea of the depth of the rock surface below the present grade of North Broad Street has been obtained. The data secured from these borings have been used as a basis for the determination of the amount of rock which will be met with in the construction of the proposed Broad Street Subway.

It is not believed that much rock will be encountered in the construction of either the loop in the business district or the South Broad Street Subway. However, in the northern end of the North Broad Street Subway, near Pike Street, the excavation will be entirely in rock.

LAYOUT OF MACHINE TOOLS FOR A LARGE
LIGHT MANUFACTURING PLANT*(Continued from Page 363)*

Although the routing advantage is by far the most important of this scheme, there are others well worth considering:

The output of each department is concentrated. Responsibility for the correctness and accuracy of the work is definitely located.

The superintendent or foreman, having the whole process on his particular part under his eye, can more easily figure out improvements in the method of doing the work. He can experiment with changes in the sequence of operations, combinations of operations, etc.

3. *Preliminaries to Making Layout Drawings.*—As a preliminary to making the drawings of the machine layout, studies are made of the best arrangement for each type of machine, taking into account drives, aisle space, delivery and discharge of materials, lighting and method of operation; that is, whether each machine has its operator, or one man runs several machines. The data for these studies are obtained from the manufacturers of the machines, who furnish prints showing the maximum floor space occupied by the machine, and also giving the required data concerning size of the driven pulley on the countershaft, and its speed.

This is done for each type of machine tool, the results are tabulated in terms of floor units, a unit being a panel of the floor, or a fraction of a panel. Thus, for example, a panel 40 feet by 24 feet may contain 20 power millers, 24 hand millers, or 15 lathes.

Where method (a) is used, grouping machines of one style together, the layout now consists merely of duplicating the typical panel studies until all machines have been accounted for.

Where the second method is used, the procedure is as follows:

Using these typical layouts as a basis, the area occupied for the manufacture of any part may be found by summing up the spaces required for its component operations. Thus, in the example, $7\frac{1}{2}$ panels are required for this one piece. A general plan of the available floor space is then used to lay off the various areas and arrange the different departments in all sorts of combinations, until what appears to be the best plan results. Due allowance must be made for non-producing departments, such as tool-room, machine and tool repair shop, toilet and locker rooms, foremen's and inspectors' offices, store-rooms, assembling and shipping departments, general office and drawing-room (if in the same building).

4. *Arrangement of the Layout Drawings.*—Drawings are made of each floor, or part of a floor, showing each machine as a rectangle of its clearance dimensions. A

scale of one-eighth inch to the foot is usually sufficient, and no dimensions need be given if the drawing is made accurately to scale. A scale of one-quarter inch to the foot, with dimensions, is preferable, as it gives an opportunity to show the shafting and to give the size of the pulleys. These drawings should indicate clearly the operating side of each machine. The dimensions should not be given to the clearance lines, but to some definite point on the machine, such as the spindle, or edge of cone pulley, so that the millwright will have no trouble in locating it. Dimensions should be tied in at frequent intervals to the column centers.

The countershaft and the belts from line shaft to counter should be shown once for each line of machines in each group, but the counter location need not be dimensioned. It is often necessary to make quite a study in order to get the belts across from line shaft to counter without interference, especially if the machines are small and close together. It is sometimes necessary to work out the exact location of the hangers on the line, although the millwright generally puts them where he wants to, regardless of the drawing.

5. *The Power Layout.*—When the work described under the preceding heading has been finished, the drawing is turned over to the power squad, who locate the motors and determine their size. The data for the power required for the machines are furnished by the manufacturers, supplemented by results of any tests made under the same conditions, or records of results with similar machines.

The figures given by the manufacturers are usually too high where group drive is used, so about 25 per cent. of the horsepower they give is used. To this is added an allowance for line losses, say 20 per cent. The net result is about 30 per cent. of the manufacturers' rating.

The machines are taken in groups so as to give a length of line shaft of from 75 to 125 feet, or so as to give motors ranging from 35 to 75 horsepower. The motors are located about the center of each group of machines. The power squad may also take care of the pulleys, belting, shafting, etc. The size of the pulleys is calculated from the assumed speed of lineshaft and the speed and size of pulleys on the countershaft. The speed of countershaft as given by the manufacturers is usually calculated for carbon steel cutters, and will have to be revised if high-speed steel cutters be used. The lengths of belting required can be scaled from the drawings with sufficient accuracy for placing the order, and the length of shafting can be handled in the same way. For simplicity and interchangeability it is preferable that the same size line shafting be used throughout, and run at about the same speed. Line shaft will be from $1\frac{15}{16}$ to $2\frac{7}{16}$ inches in diameter for light machinery. Speed from 150 to 300 revolutions per minute.

ENGINEERS' CLUB OF PHILADELPHIA

SOME RANDOM OBSERVATIONS ON THE RELATION OF THE JUNIOR MEMBER, ETC.

(Continued from Page 377)

be charged with "straining at a gnat and swallowing a camel." Some people think in terms of an eighth of an inch, or some such small denomination, and are always looking for perfection in details, and in many instances overlooking the "*tout ensemble*." This subject can well be brought out in the meetings of the Juniors in the discussion of engineering matters of more or less importance, and especially those foremost in the public view.

The Juniors may well supplement the activities of the Engineers' Club by calling the attention of the Club to any matters in which it is thought it may be concerned, and in which it may be desired that the Club take action. The Club has a Public Relations Committee before which the Juniors may appear, either collectively or through representation or individually,

from time to time, to present such matters, and it goes without saying that they will at all times receive courteous attention, and the matters they present will be given serious consideration.

One other point: A working knowledge of parliamentary law and some experience in parliamentary practice should be an important part of an engineer's education, and few possess even the rudiments of it. Without such knowledge no meeting of any character whatever can be conducted properly. It is rather a broad statement, but none the less true, that the vast majority of engineering meetings, from this point of view, are imperfectly conducted. This is another topic in which the Juniors should seriously concern themselves.

On the whole, membership in the Junior grade should be a sort of post-graduate course in all the essentials leading up to a full, Active Club membership.

COMMITTEE REPORT—JUNIOR SECTION

June 18, 1917.

To the President and Board of Directors of the Engineers' Club of Philadelphia.

GENTLEMEN: At the last meeting of the season of the Junior section of the Club, held on May 28, 1917, the part that the Juniors could and should play in the various Club activities was thoroughly discussed. At this meeting the undersigned were constituted a committee to put in a definite form what seemed to be the general consensus of opinion. Mr. Swaab, who honored us with his presence that evening, is familiar with the subject matter discussed in this communication. The following is a brief outline:

It is suggested that the Junior members be organized in a manner somewhat similar to that of the affiliated societies, having their own chairman, executive committee, and papers committee. The activities of the latter to be subject in all cases to the approval of the Club proper, it being thought that this could be best accomplished by having a member of the Club an *ex-officio* member of all Junior committees, and also to act as *ex-officio* chairman. We suggest Dr. Boehm for this office, inasmuch as he has exhibited such marked interest in Junior affairs and has become very popular with the Juniors.

We realize that there is no provision made for or against such a Junior organization in the Constitution or the By-Laws of the Club, but we believe that the section regarding the various affiliated societies could be made to apply.

It is our conviction that the adoption of the foregoing proposals in whole or in part would greatly stimulate the interest of the Juniors, cause them to be a valuable adjunct of the Club instead of a dead weight, and thus enable them to be better and more useful Senior members when they become such.

Respectfully submitted,

THE JUNIOR SECTION.

(Sd.) { H. I. GOLDSTEIN, *Chairman*.
A. B. BISHOP.
Committee— { A. B. GODSHO.
WILMER Z. KLINE.
W. W. PICKLES.

REGULATIONS FOR THE AVIATION SECTION OF THE SIGNAL OFFICERS' RESERVE CORPS

1. *Qualifications of Candidates.*

As all pilots in our Military Air Service will receive commissions, it is of the utmost importance that candidates for examination possess those fundamental qualities of character and mind essential in officers of every grade in our army. Aviation officers in particular must be young, in as near as possible perfect physical condition, mentally alert, and have at least a good general education, preferably along mechanical lines.

The minimum age limit has been fixed at nineteen and the maximum at thirty years. The physical fitness of an applicant will be determined by one of a number of medical officers stationed in various cities and towns throughout the country.

While for obvious reasons it is highly desirable that all aviation officers should have completed a course of instruction in a college or technical school of recognized standing, the fixing of the minimum age limit at nineteen years, due to the fact that very young officers often show exceptional efficiency in the air service, does not make it feasible to insist on a college degree or the equivalent of a college course as an essential requirement. The candidate must have, however, completed at least the equivalent of the courses offered in the best of our high schools.

2. *Process of Obtaining Commission.*

The applicant for a commission must fill in the enclosed forms, marked Exhibit "A" and Exhibit "B," sign form No. 1, and return all, with three letters of recommendation, from responsible citizens, to The Chief Signal Officer, U. S. Army, War Department, Washington, D. C. If the information afforded leads to the conclusion that the applicant belongs to what may be called officer material class, he will be advised where and to whom he must report for an examination. (*Blanks may be obtained upon application to the Secretary of the Engineers' Club.*)

Assuming the examination—a physical and an oral one, the latter along the lines of the questions in Exhibit "B"—successfully passed, the applicant is enlisted as a Private, First Class, Aviation Section, Signal Enlisted Reserve Corps, and sent for a period of eight weeks to one of what are known as "ground" schools (military schools of aeronautics), a number of which have been organized at universities and colleges in various parts of the country.

The course of instruction offered, in addition to that relating to military matters, drill, machine gun practice, etc., includes the principles of mechanics, internal-combustion engines, wireless telegraphy, and

flight, all supplemented by laboratory work. After work at the ground school, about four months more are spent at an aviation training school. If, at the end of this time, satisfactory proficiency is shown, the applicant receives a commission as First Lieutenant in the Signal Officers' Reserve Corps, Aviation Section. If applicant fails in his final flying test, he may apply for a discharge to enter another branch of the service if he so desires.

On becoming a Private, First Class, applicant is furnished by the Government with a uniform, is allowed commutation of quarters and rations, and transportation expenses to ground and aviation training schools. In addition, he receives the usual pay of a private of the first class, \$33 per month.

EXHIBIT "A"

WAR DEPARTMENT SIGNAL CORPS, U. S. ARMY

.....
(Present address)

....., 19..
(Date)

TO THE ADJUTANT GENERAL OF THE ARMY,
War Department,
Washington, D. C.

SIR: I have the honor to apply for examination for a commission as ¹..... Aviation Section, in the Signal Officers' Reserve Corps, organized under the authority of Congress.

I have served years in ².....

I have pursued a regular course of instruction for years in ³.....

I graduated in the year from ⁴..... after having creditably pursued the course of military instruction therein provided.

I was born, ¹....., at, and am ⁵..... a citizen of the United States. Age Color Height Weight My business is

ENGINEERS' CLUB OF PHILADELPHIA

My experience is ⁶.....

I inclose letters of recommendation and addresses of three citizens who know me, as follows:

Respectfully,

Permanent P. O. Address:

The correctness of the statements above made was sworn to and subscribed before me
, 19...

⁷.....

¹ Insert grade, first lieutenant, captain, or major.

² Insert service in the Regular Army of the United States, or Volunteer forces of the United States, or Organized Militia of any State, Territory, or District of Columbia; also state in what capacity.

³ Insert name and location of the school or college.

⁴ Insert the name and location of the educational institution.

⁵ Insert "not" if in accordance with fact.

⁶ Business or otherwise.

⁷ Oath to be taken before, and signature to be made by, officer authorized by law to administer oaths.

EXHIBIT "B"

QUESTIONS FOR EXAMINATION OF APPLICANTS AVIATION SECTION, SIGNAL OFFICERS' RESERVE CORPS

(Place)

(Date)

.....
 Candidate for commission, A. S. S. O. R. C.

1. Have you appeared before any other examination board for a like examination for the Aviation Section, Signal Officers' Reserve Corps?

2. What is your present occupation?

3. What has been your business or occupation for the past four years?

4. Give list of schools attended, with years.

5. What collegiate or academic degrees have you, if any?

6. With what foreign languages are you familiar? State in full

7. Have you any technical knowledge? If so, state its character

8. What forms of athletic exercise do you keep up at present?

9. Name sports or athletic activities in which you participated while in school, or afterwards

10. When in school or college, were you a member of any athletic team? If so, in what year, and what position did you occupy?

11. Can you drive a motor car, make minor repairs and adjustments?

12. Can you ride a motorcycle, make minor repairs and adjustments?

13. State fully your theoretical and practical knowledge in the care and repair of gasoline motors

14. Have you ridden horseback to any extent? ...

15. Can you sail a boat?

16. Have you undergone any course of military instruction? State fully

17. Have you had any aviation experience? State fully

18. To what extent do you use intoxicants?

19. Have you ever been dismissed from any kind of employment on account of misconduct or inability? If so, state circumstances

20. What qualifications do you consider you possess which allow you to state that you have the equivalent of two years' college education?

I certify on honor that the foregoing statements are true and complete to the best of my knowledge and belief.

(Signature)

Candidate for Commission, A. S., S. O. R. C.

Approved, May 21, 1917.

C. McK. SALTZMAN,

Acting Chief Signal Officer.

FORM 1

I certify that if I am assigned to duty to take the course as prescribed in Special Regulations No. 50, 1917, I will undergo the complete course and remain on duty until relieved by proper authority, and that if I pass the Aviation Tests as prescribed in the above special regulations, I will accept a commission in the Aviation Section, Signal Officers' Reserve Corps.

(Sign here)

I certify that, to the best of my knowledge and belief, I am not affected with any form of disease or disability which would interfere with the performance of the duties under the commission for which I am undergoing examination.

(Sign here)

THE AMERICAN UNIFORM BOILER-LAW SOCIETY

(Continued from Page 383)

have steadfastly adhered strictly to our cause, and not participated in any legislative matters pertaining to the manner in which the code should be applied or who should have jurisdiction over it. These are matters which must be settled in the various states according to the existing conditions and the desires of the people in power.

We would report to you in detail the following progress:

NEW YORK

The Code Committee of New York has formally adopted the A.S.M.E. Code and reported it favorably to the Industrial Commission. The date at which it will go into effect has not yet been fixed.

The New York State Industrial Commission paid our organization the compliment of asking us to sit in an advisory capacity with them during all their proceedings.

Probably no state will give the matter of the boiler code greater care than did the state of New York. The Code Commission of the state went up and down through the state, and then published a tentative code, and went up and down the state again, getting criticisms and comments of this code, pursuing much the same course that the Code Committee of the American Society of Mechanical Engineers pursued in the formation of the A.S.M.E. Code, but gave the public greater chance, perhaps, to criticise and make suggestions than has ever before been accorded. Meetings were held in Buffalo, Syracuse, Rochester, Utica, Albany, and New York, and much interest was developed and much valuable information obtained. It is a great compliment to our code that, after all this strenuous work, A.S.M.E. Code was adopted verbatim.

We believe that the adoption of the code in New York State is of vast importance to our cause, as New York is unquestionably one of the leading states in the Union.

MICHIGAN

Our Enabling Act was passed unanimously by the House and Senate, and has been signed by the Governor, and the committee will be appointed to proceed with the adoption of the code.

In all the effort that we made it was with the understanding that the A.S.M.E. Code would be adopted.

Great assistance was rendered to our cause in Michigan by Dr. J. C. McCabe, Chief Inspector of Steam Boilers of the City of Detroit; Prof. M. E. Cooley, of the University of Michigan; Professor Bissell, of Lansing, and Mr. E. H. Fisher, of Saginaw.

NEW JERSEY

An Enabling Act was passed by the Legislature, and signed by the Governor, the same as in Michigan, and we understand that the committee has been appointed, and in due time New Jersey will issue the code and the date of its going into effect.

Our cause was very strongly supported in New Jersey by Col. Lewis T. Bryant, Commissioner of Labor.

MINNESOTA

Minnesota has issued a notice through the duly appointed representatives of the Inspection Board of the state that on and after January 1, 1918, all the boilers must be made according to the Boiler Code of the American Society of Mechanical Engineers. This has been approved by the Governor, and renders the code absolutely effective after the date mentioned.

Much of the credit for the accomplishment of this is due to Mr. Max Toltz and Mr. Oliver Crosby, of St. Paul.

MISSOURI

Our bill failed in Missouri, due to political reasons, but the city of St. Louis has passed the code to put it in operation, as has also Kansas City. With the example set by these two great cities of the state, we believe that at the next meeting of the Legislature we will have no trouble in having the code adopted by the state of Missouri.

COLORADO

In Colorado we did not succeed in getting the bill introduced to the Legislature, due to the fact that there was political turmoil during most of the session of the Legislature, and, as a matter of fact, it is our belief, based on the advice of competent attorneys, that it is not necessary to get a bill passed in Colorado in order to have the code adopted, as the new Industrial Commission of the state will have the power to adopt the code. We are in correspondence with the Commission at this time.

We had our bill introduced in the following states, where it failed of passage, due to various reasons:

Washington	Tennessee	Iowa
Oregon	Rhode Island	Utah
Texas	New Hampshire	Kansas
	South Dakota	

However, we are confident that in every one of these states we shall be able to have the code passed at the next meeting of the Legislature. It entailed a great amount of work and the coöperation of many loyal supporters of the code to get the bills introduced in the above states, and get the publicity which the code needs in order to get it put into effect. Our campaign has been largely one of education and publicity, and it is our firm belief that publicity will accomplish any legislation of merit, and it is almost impossible to get legislation passed, no matter how meritorious it may be, without the proper kind of publicity.

While we are disappointed, as stated previously, at not getting more net results, yet on the whole we are inclined to the belief that the code now has made such progress that its momentum will be irresistible at the next meeting of the Legislature, which will be, in most states, two years hence.

In no states was the code defeated on its merits. The arguments in favor of the code have not been successfully met in any state. All agree on the necessity for a code, and in no state has the A.S.M.E. Code been successfully attacked.

ENGINEERS' CLUB OF PHILADELPHIA

CANADA

The Province of Manitoba is revising its boiler code, and expects to call a meeting in the near future with the idea of getting the coöperation of the other provinces in Canada, with the hope that universal rule can be made for Canada. We are in correspondence with the various provinces, and there has been expressed a desire to make the A.S.M.E. Code operative in Canada. In this we have the strong support of the Province of Ontario, which is one of the leading provinces in Canada, and also the support of the leading boiler manufacturers throughout the entire Dominion.

We expect to accomplish great good in the way of giving the A.S.M.E. Code extended publicity through this meeting, and our hope is that at least one or two of the provinces will reach a point where they will accept code boilers.

MASSACHUSETTS

Our situation in Massachusetts has not been materially changed. We had hoped from the earnest effort that Mr. Luck put forth in attending the meeting in Washington, and also the public meetings of the Code Committee of the American Society of Mechanical Engineers, that by this time we could report some progress in Massachusetts, but unfortunately we cannot do so.

The Massachusetts Board of Boiler Rules, through Mr. Luck, has approached various states which have adopted the code, and asked them to accept Massachusetts boilers, and this request was generally favorably considered, but when the states which had adopted the code asked for reciprocity, it was denied them, and the

consequence was that the favorable action toward Massachusetts boilers was refused. Massachusetts was not willing to accord to other states the recognition that she herself was seeking. Consequently, in one case to our knowledge, the favorable action toward Massachusetts was withdrawn and Massachusetts boilers cannot now be shipped into this state. We think that perhaps this may have a beneficial effect on Massachusetts.

The states and cities in which the code has been adopted, or in process of adoption, are as follows:

New York	Indiana
New Jersey	Michigan
Pennsylvania	Wisconsin
Ohio	Minnesota
California	
Kansas City and St. Louis, Missouri	

With the progress that we have now made, we predict that the code will be practically universal within a period of four years more.

Respectfully submitted,

THOS. E. DURBAN,
Chairman.

TED: E
ERIE, PA., June 15, 1917.

POSTSCRIPT

We have just been advised by the State Industrial Commission of New York that the Commission, at a meeting held June 5, 1917, adopted the proposed rules for boilers in factories in the state of New York, as formulated by their Advisory Committee, effective July 1, 1917, new construction, effective January 1, 1918.

URBANA, ILLINOIS,
July 18, 1917.

If every householder and owner of a small house heating plant in the state of Illinois would use reasonable care in the purchase of his fuel in the operation of his plant, the saving would be equivalent to 4,500,000 tons of coal. According to a circular just issued by the Engineering Experiment Station of the University of Illinois such a saving is easily within the range of practical attainment. Applied to the entire United States, intelligent attention in the operation of house heaters would save more than sixty million tons of coal.

The University of Illinois has discussed, in the circular referred to, the more important factors involved in the installation of a satisfactory house heating system, and has set forth the most economical methods of firing soft coal and operating a house heating plant. The properties of fuels, and the processes attending

their combustion are discussed in a fashion which is intended to help the average householder to understand his problem and to secure the economics of intelligent operation.

Tables giving the trade names, geologic names, and average heating value of the coals of the central western area are contained in the circular and a chart is presented to show the relative worth of coals of different heating values. Some attention is also given to the properties of Eastern coals.

Diagrams in color illustrate the usual heat losses which occur and suggest the means to be employed in overcoming them. Methods and devices for regulating house heaters are shown by drawings, and the importance of proper chimney height, of air-tight flues, and of various dampers and regulators is emphasized by a number of illustrations.

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CONTENTS OF THIS ISSUE

	PAGE		PAGE
Notes on the Electric Storage Battery.....	395	List of Subscribers to Building and Equipment Fund, Complete to August 24, 1917.....	428
By EDWARD WANTON SMITH, Ch.E.			
Early Chemical Manufacturing in Philadelphia....	411	Calendar of Regular Meetings of The Engineers' Club and Affiliated Societies—1917-1918.....	433
By SAMUEL P. SADTLER			
The Position of the Engineer in the Community and His Relations to the Contractor.....	415	Secretary's Notices	434
By S. M. SWAAB		Committee on Coöperation for National Defense... ..	435
Need of Technical Men	417	GEORGE R. HENDERSON, Chairman	
Code of Lighting—Factories, Mills and Other Work Places	418	Committee on Membership.....	436
By Courtesy of the ILLUMINATING ENGINEERING SOCIETY		D. ROBERT YARNALL, Chairman	
Officers, Directors, Standing and Special Committees of Engineers' Club.....	424	Situations Vacant and Position Wanted	436
Editorial	425	American Society of Mechanical Engineers.....	437
The Building and Equipment Fund Campaign.....	426	American Institute of Electrical Engineers.....	437
		Index to Advertisers.....	x

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C NEW SPANISH-ENGLISH DICTIONARY

cienso, *sm.* mud.
ciento, *a.* one hundred;
—, *sm.* a hundred.
cierno, *en*—, in blossom;
estar *en*—, to be in (its)
infancy.
cierto, *sm.* enclosure.
cierto, *a.* certain; evident.
cifra, *sf.* cipher; abbrevi-
ation.
cigarro, *sm.* cigar.
cigarrito, *sm.* cigar-
ette.
cilla, *sf.* summit; nap;
cima, *sf.* top of trees.
cimentar, *s.d.* to lay the
foundation of a build-
ing; to ground; to re-
fine metals.
cimentario, *sm.* cement.
cimentel, *sm.* chisel.
cinco, *a.* & *sm.* five.
cincuenta, *sm.* fifty.
cincuenteno, *na.* a.fiftieth.
cinchar, *s.d.* to girth.
cinematógrafo, *sm.* cine-
matograph (moving
pictures).
cingaro, *ra.* a. gipsy.
cinta, *sf.* ribbon; tape.
cintura, *sf.* girdle; waist.
circo, *sm.* circus.
circuir, *s.d.* to surround.
circulación, *sf.* circula-
tion; currency.
circular, *a.* circular; circu-
latory; —, *s.n.* to cir-
culate.
círculo, *sm.* circle; circum-
ference; district; orb;
compass.
circunstancia, *sf.* circum-
stance.
circunvecino, *na.* a. neigh-
boring, adjacent.
cirineo, *sm.* mate, assist-
ant.
ciruela, *sf.* plum, prune.
cirujano, *sm.* surgeon.
cisterna, *sf.* cistern.
cita, *sf.* appointment, ap-
pointment, rendezvous;
signation, quotation;
citación, *sf.* quotation;
summons.
citano, *sm.* such a one.
citerior, *ad.* hither, nearer.
ciudad, *sf.* city; civic
body.
cívico, *ca.* a. civic.
civil, *a.* civil; polite, cour-
teous; (law) not crim-
inal.
civilizar, *s.d.* to civilise.
civismo, *sm.* patriotism.
clamor, *s.d.* to clamor.
clamo, *sf.* short interval of
clear weather on a rainy
day; white of an egg.
clarar, *s.n.* to dawn; —, *ss.*
to be transparent; to
clear up.
clarete, *a.* vino —, *sm.*
claret.
clarín, *sm.* trumpet; trum-
pet.
claro, *ra.* a. clear, bright;
intelligible.
clase, *sf.* class, rank; or-
der.
clasificar, *s.d.* to classify.
claudicar, *s.n.* to halt, to
limp.
cláusula, *sf.* period; clause.
clavara, *s.d.* to nail; to
fasten in, to force in; to
drive into; to drive a
wedge; (fig.) to cheat, to
deceive.
clavícula, *sf.* clavicle.
clavija, *sf.* pin, peg.
clemencia, *sf.* clemency.
Pron. a. ah; e. ay; i. ee; o. oh; u. u (in full); y. ee.

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No. 154

NOTES ON THE ELECTRIC STORAGE BATTERY *

EDWARD WANTON SMITH, CH. E.

IN discussing the storage battery it may be well, first of all, to consider the electrochemical reactions, conditions, and limitations upon which its operation depends, and to anticipate the question which will present itself to the minds of many, accustomed to all kinds of chemical problems. It is natural to inquire, when we know of so many thousands of chemical reactions that might be supposed available—Why is it necessary to make storage batteries of such a heavy and undesirable material as lead? The alkaline battery answers the question partially, inasmuch as no lead is employed in its construction; but it possesses certain characteristics that very much limit its field, so it is still in order to ask why the ordinary storage battery of commerce is made of lead. To be perfectly frank, no concise reason can be given to show that lead makes the best material, but a brief analysis of the question very much narrows down the possible combinations.

GENERAL CONDITIONS

What is necessary to constitute a storage battery in the broadest sense?

We must have in any electrolytic cell two electrodes to permit of the entrance and exit of the current, and between the two an electrolyte capable of conducting the current. If the cell is to be capable of giving off energy (that is, if it be a battery), there must be forces set up within it tending to cause such a motion of the ions as to liberate (in the conventional meaning of the terms) positive charges at the one pole and negative charges at the other. Referring to Fig. 1, the cation A , in leaving the negative electrode a , carries with it a positive charge, leaving the electrode negatively charged; while similarly the anion B , leaving the positive electrode b , carries with it a negative charge, leaving b positively charged. The two ions A and B liberated in the electrolyte must then combine to form a stable compound, and it is their chemical affinity for each other which furnishes the energy of the electrical discharge. If the cell is to be a storage battery, all the actions involved must be completely reversible, so that when an electric current is driven through the cell in opposition to its electromotive force the motions

of the ions are exactly reversed; so that a charge restores both electrodes and electrolyte to their respective original conditions. The field of chemical reactions which might answer qualitatively for this purpose is so broad that I should not like to hint at its possibilities,

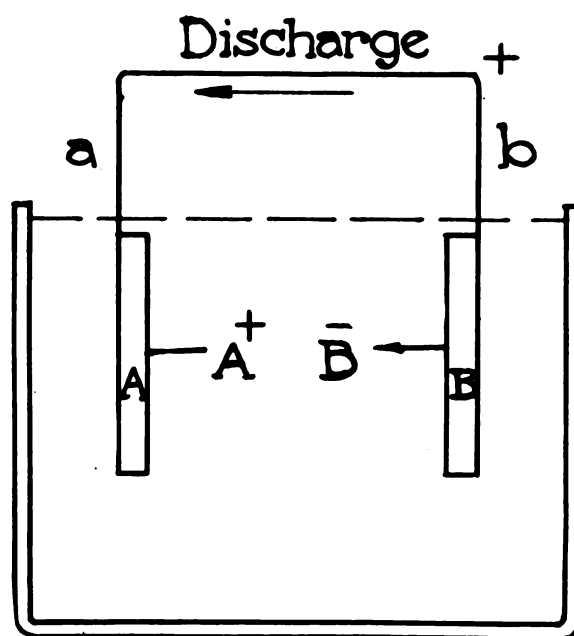


Fig. 1

but I want to call attention to some of the steps which have led to the present types.

THE ELECTROLYTE

Consider first the electrolyte. Above all else, it must be a stable liquid and a relatively good conductor of the second class, under normal temperature. Altho plenty of organic substances may, under certain conditions, constitute electrolytes, their ionization power, and consequently their conductivity, is invariably low. Water, on the other hand, tho not itself a conductor, possesses in an exceptional degree the power of ionizing substances held in solution and hence it forms the basis of an endless number of solutions of high conductivity. Water, moreover, has another distinct value, in the readiness with which it splits up and

*Presented before Philadelphia Section of American Chemical Society at the Engineers' Club, May 17, 1917.

enters into the various reactions of the cell, ready at all times to act as either reducing or oxidizing agent, as occasion may demand.

It is true that the presence of water appears to have one distinct drawback, namely, that it limits the electromotive force of the cell to that at which water becomes decomposed; for it is self-evident that if the chemical forces are so great as to decompose the water spontaneously, they will do so at the expense of the energy available as electric current.

It is quite within the range of possibility that a battery might be made having a non-aqueous fused salt or base as electrolyte, and that such a cell might have a higher voltage than that we are accustomed to; yet the probability of such being successful is extremely remote, and it is a fair statement of facts, as at present known, to say that water must constitute the basis of the electrolyte used in all storage batteries of commercial value.

CHEMICAL ACTIONS OF CELL CLASSIFIED

As to the chemical actions which furnish the energy of the cell, these may be classified into four main groups, each of which has been developed at least to the point of being tried out commercially.

The reactions in most cases are more intricate than indicated, owing to the fact that the water and gener-

stances A and B and for the carrying off of the charges liberated as the ions assume the molecular state. During the charge, the current, forced against the electromotive force of the cell, imparts a positive charge to the positive electrode b , which in turn attracts the negatively charged anions B and, robbing them of their

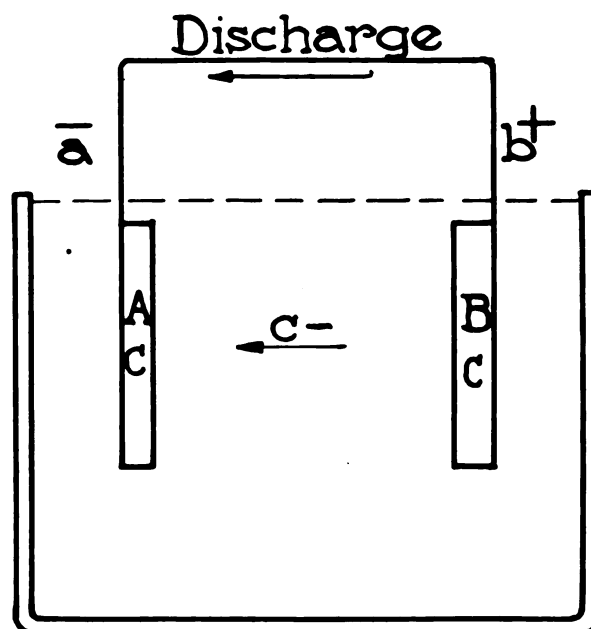


Fig. 3.

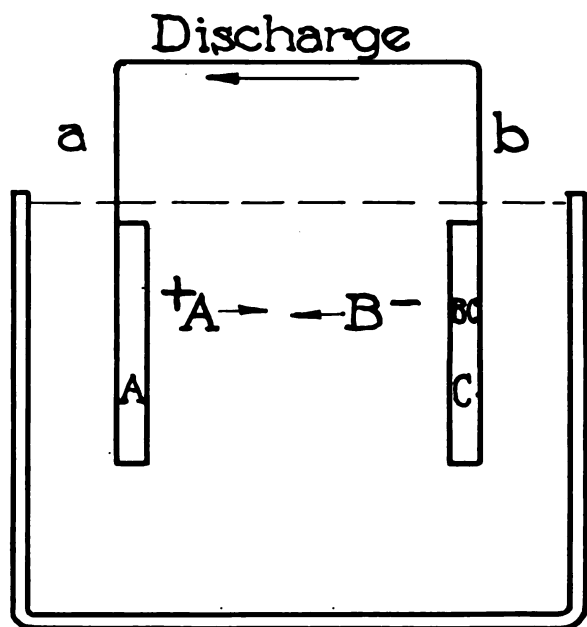


Fig. 2

ally the dissolved substance of the electrolyte enter into various intermediate or secondary actions.

The first class represents the simplest reaction possible, as illustrated diagrammatically in Fig. 1. The two electrodes a and b are insoluble in the electrolyte and serve merely for the deposition of the two ionic sub-

stances A and B and for the carrying off of the charges liberated as the ions assume the molecular state. During the charge, the current, forced against the electromotive force of the cell, imparts a positive charge to the positive electrode b , which in turn attracts the negatively charged anions B and, robbing them of their

charge, converts them into ordinary molecular matter; while at the negative electrode a positive electricity is withdrawn, leaving a negatively charged, so that it attracts the cations A , which similarly give up their charges and are converted into molecular matter. The attraction of the substances A and B for each other being greater than the sum of the attractions of each for itself, there is a constant tendency for them to recombine, and as soon as the potential difference between a and b falls below a certain value, recombination takes place. This recombination takes place, however, only as the molecules break up into ions; and as this implies that the cations A take with them each a minute positive charge, while the anions B take each a negative charge, it is clear that a current from a to b is a necessary result of the action.

The second class of battery (Fig. 2) differs from the first only in that the cation B , instead of being deposited directly upon the positive electrode b , is liberated in contact with a so-called "active material" C , with which it forms a stable compound, BC . In practically every case the substance c is not a simple element, but a metallic superoxide, and the reaction which it performs during discharge is that of oxidation of the anion substance B liberated in contact with it. The fundamental actions of this type of cell are accompanied by secondary actions which complicate the

actual *modus operandi*, as will appear when the reactions of an actual cell are examined.

The third class has at both electrodes active materials, both of which may combine with an active ion of the electrolyte, but with different degrees of affinity, so that an energy change is involved in the process of transferring the ion from one to the other. Referring

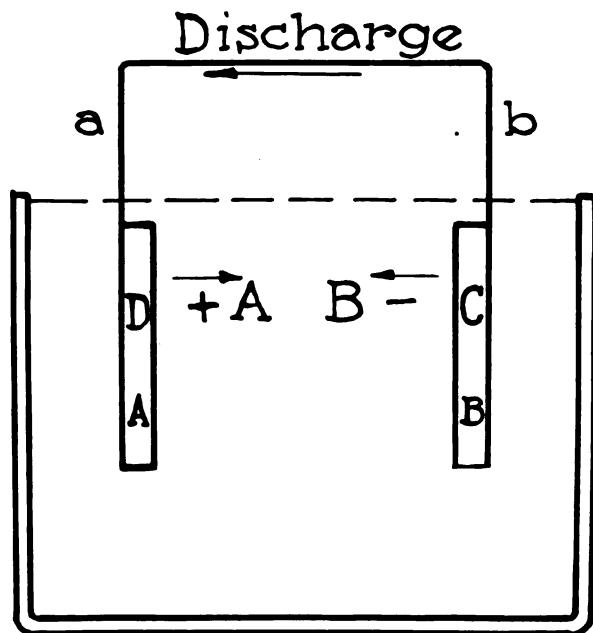


Fig. 4.

to Fig. 3, the active materials *A* and *B* both combine with the active ion *C*, but one of them, *A*, has a much greater affinity for it than *B*, so that there is a tendency for the ions *C* to pass from *B* to *A*, with the resultant production of an electric current in the direction noted.

The fourth class (Fig. 4) resembles the last, in that both electrodes contain "active materials," but differs in that the active ions of the electrolyte, during charge and discharge, are merely transferred back and forth between one or both electrodes and electrolyte, and not from one electrode to the other. Referring to the diagram, *C* and *D* are active materials capable of combining with the active ions of the electrolyte *A* and *B*, the summation of the affinities of *A* for *D* and of *B* for *C* being greater than that of *A* for *B*. It must be admitted that here also secondary reactions occur under actual conditions which considerably complicate the mechanism depicted in the diagram of this class of batteries.

EXAMPLES OF THE FOUR CLASSES

Let us examine the actual cells belonging to these four groups and ascertain where the capabilities and limitations of each lie.

As an illustration of the first class the zinc bromide cell may be taken (Fig. 5), there being in this case

no secondary actions and the two elements of the dissolved substance constituting the complete working parts.

The active constituent of the electrolyte consists of zinc bromide, which, upon the passage of the current, separates into metallic zinc deposited upon the negative plate and liquid bromine at the positive.

The negative plate, *a*, of carbon is placed horizontally slightly below the surface of the electrolyte, while the positive, *b*, also of carbon, preferably resembling a honeycomb, is disposed below it at the bottom of the cell.

The mutual affinity of the zinc and bromine is the force which gives the electromotive force to the cell; yet they cannot recombine except as ions, and they are not free to split off from the electrodes as ions except they impart thereto the charges which cause the flow of current in the external circuit.

The defects and limitations of this cell are such that it has never attained commercial value. As it contains but two plates, its internal resistance is consequently high; it will not stand any degree of vibrating motion or rough handling, and even when in a state of rest the

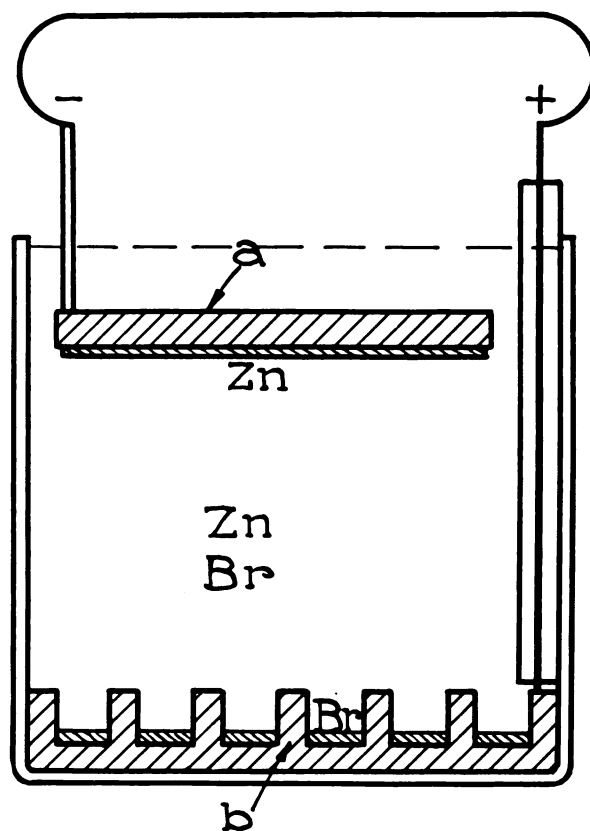


Fig. 5

bromine at the positive electrode slowly dissolves in the electrolyte, reaching the deposited zinc at the negative. It there combines directly without the generation of any useful current, so that the cell is always subject to local action, and the deposition of the zinc is very unsatisfactory.

While this type of cell has the advantage of extreme electrochemical simplicity, very few actual combinations can be found to fit it; and the difficulties experienced with all soluble and redeposited negative plates appear to be insurmountable.

The second class has on its face many advantages,

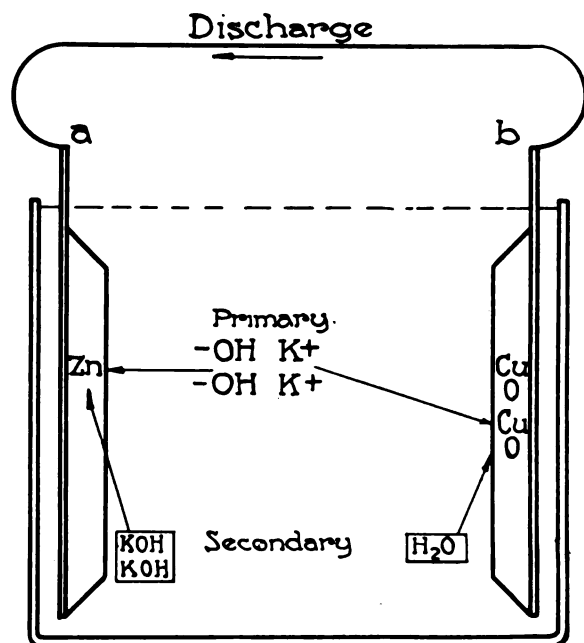


FIG. 6.—WADDELL-ENTZ CELL.—RESULT AFTER DISCHARGE. K_2ZnO_2 (SOLUBLE). $2H_2O$. Cu_2O (DISCHARGED ACTIVE MATERIAL). $2KOH$ (SOLUBLE).

and much human effort has been expended in trying to develop it, and, indeed, as a primary battery, it is in extensive use to-day under the name of the "Edison Lelande." A partially successful attempt to utilize this form of reaction as a storage cell was made by Waddell and Entz, some twenty-five years ago. Their cell contained as electrolyte caustic potash; the negative plate was a sheet of steel with zinc deposited upon it, and the positive consisted of a copper network enclosing a body of porous copper oxide. The reactions which took place are indicated in Fig. 6; the final result of discharge being that zinc is dissolved at the negative pole, while hydrogen is released at the positive, where it combines with the copper oxide, with the formation of water and copper sub-oxide.

The Waddell-Entz cell at first gave great promise of success, but was finally found to possess a fundamental defect which money and brains, freely expended, were unable to remedy. This defect lies with the redeposition of the zinc upon the negative plate. Deposition takes place quite regularly and nicely for a few cycles of charge and discharge, but then becomes irregular, the heavy zinc solution accumulating at the bottom of the cell, causing the formation of trees, that eventually result in short-circuits.

To a certain extent this defect was lessened by surrounding the copper pole with a cotton bag, which acted as a diaphragm and kept the zinc solution away from the

positive pole; but the bags proved unreliable, the short-circuits continued, and the battery proved a failure.

This is, then, the one general defect of this type: it is impossible to dissolve and redeposit any metal in a long-continued cycle of operations without producing uneven deposits, trees, and short-circuits, which finally put the cell out of business. In view of the great amount of effort expended by numerous investigators in attempts to develop a successful storage battery with negative plates based upon the principle of dissolving and redepositing, and of the ultimate failure of all from the causes mentioned, it seems we are justified in accepting it as an established fact that a soluble negative plate is not, and is never likely to be, successful.

Amalgamation has been tried, also the expedient of totally dissolving the zinc frequently so as to start the deposit afresh. Theoretically, a diaphragm should accomplish the desired end, but unfortunately the theoretical diaphragm does not exist, and so the defect still remains prohibitive.

THE EDISON CELL

As to the third class of cells, none exactly fits it in the simplicity depicted, but the various forms of alkaline battery, best represented by that of the Edison, so nearly realize it that the classification may be allowed.

In the Edison cell spongy metallic iron constitutes

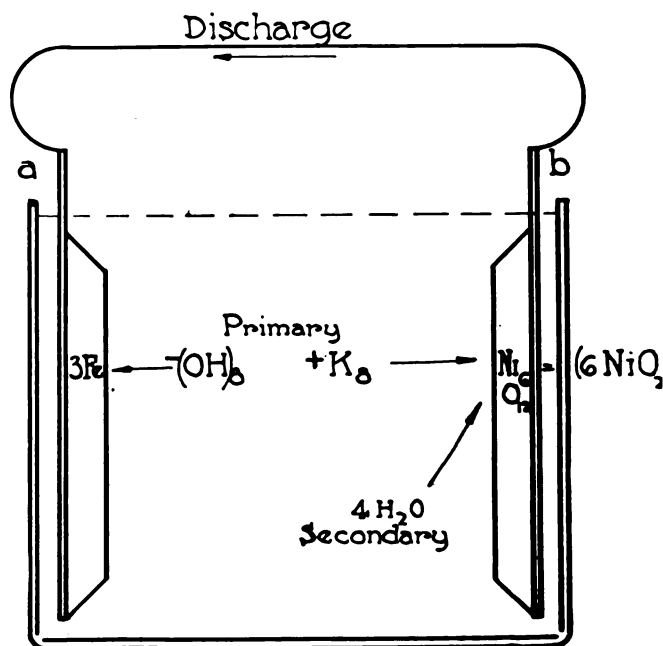


FIG. 7.—EDISON CELL.—RESULT AFTER DISCHARGE. Fe_2O_3 (INSOLUBLE DISCHARGED ACTIVE MATERIAL). $4H_2O$ EQUIVALENT TO THAT ABSORBED IN SECONDARY ACTION. Ni_2O_3 (INSOLUBLE DISCHARGED ACTIVE MATERIAL). $8KOH$ (SOLUBLE AND EQUIVALENT TO THAT DECOMPOSED IN PRIMARY ACTION).

the active material of the negative plate, peroxide of nickel the positive, while a solution of caustic potash forms the electrolyte. The process of discharge results merely in the transfer of a part of the oxygen, loosely combined with the nickel, to the iron, for which it has a strong affinity, while on charge the oxygen is pushed

or lifted back to the nickel again. The complete reaction is shown in Fig. 7, the primary action in large symbols, the secondary in small ones, and the analogy to the theoretical diagram of Fig. 2 is seen to be very close, inasmuch as the ultimate result of charge and discharge is simply a transfer of oxygen back and forth

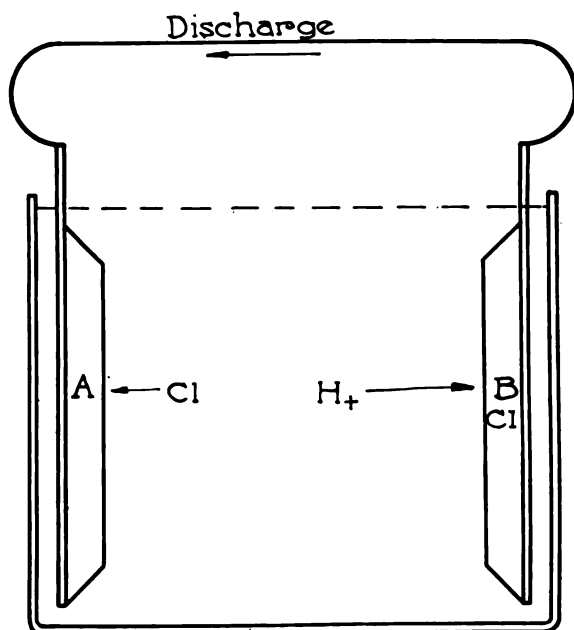


FIG. 8.—RESULT AFTER DISCHARGE. ACl. B.

between iron and nickel, the electrolyte remaining unchanged all the while.

In this type of cell none of the defects pointed out in the first two classes exist, and, in point of fact, such limitations as the Edison cell possesses are quantitative only, and where these limitations do not interfere with requirements of service, the battery is a very excellent one, which meets with many commercial applications.

We may perhaps digress to speculate on the possibility of other combinations of this same class. A number of substitutes for iron and nickel will suggest themselves; for instance, metallic cadmium as the negative, silver oxide for the positive. Both of these materials, as well as many others, have been tried and have given somewhat satisfactory results, but not so good as nickel and iron.

The requirements broadly are: The negative material must readily unite with an active element or radical of the electrolyte and must be a conductor, which practically means it must be a metal. The positive material must also unite with the same element or radical of the electrolyte, but with a lesser affinity than the negative. Both active materials must be stable in the electrolyte and must be practically insoluble in all conditions. There appears no intrinsic reason why, in this class of cell, we should not employ an acid electrolyte as well as an alkaline one, with a resultant reaction such as shown in Fig. 8. But, on the other hand, I can think of no actual combination of this kind,

using the materials we have to work with, which will fulfil the conditions and constitute a workable cell.

The Edison battery, as we now know it, is a most highly developed piece of electrochemical mechanism, and certainly bears testimony to the perseverance and skill of its inventor; and, indeed, it is an astonishing fact that, while its only rival in the field has been worked on and perfected by inventors and scientists galore for the past fifty years and more, the alkaline battery, in its highest form and as used in America to-day, is practically the work of one man and his organization.

DETAILS OF EDISON BATTERY

The process of manufacturing the Edison battery is so interesting that any broad discussion of batteries would be incomplete without at least a brief sketch of it.

The negative (Fig. 9) consists of a piece of sheet steel, with rectangular holes punched close together over the whole surface, and into which holes are inserted—small, finely perforated, metallic pockets which hold the active spongy metallic iron. The iron is placed in position as oxide, the pockets are put together and set in the holes of the frame, and the whole then subjected to heavy pressure in a hydraulic press, which locks it all together into an integral piece. It will be noted that the face of each pocket is corrugated, which, while apparently an insignificant detail, is really quite essential in order to give the pocket rigidity enough to maintain good contact with the spongy iron within.

The positive plate of the Edison cell (Fig. 10),



FIG. 9.—EDISON NEGATIVE PLATE FOR VEHICLE USE. (1/2 SIZE) altho it plays a relatively small part in so far as concerns the actual storage of energy, is the one which has caused the greatest difficulties in manufacture, and as it stands to-day it is almost comparable to a watch in the perfection of its detail, and it is impossible to do it justice in the space here available.

Two main factors which experiment showed to be

of great importance in the design of a nickel peroxide plate were, first, that the contact between the conductor and the material, as well as between the particles of the material itself, was apt to deteriorate with use, and that, therefore, a considerable pressure must be at all times exerted upon the nickel oxide; second, that the conductivity of nickel oxide was at best very low, so that some good conductor must be distributed thru it to help out in this respect. To attain the first object the use of cylindrical perforated steel tubes as the best form for exerting pressure on the contained mass was adopted, while the second point is covered by subdividing the contained nickel oxide by means of a number of thin nickel disks about one-eightieth of an inch apart.

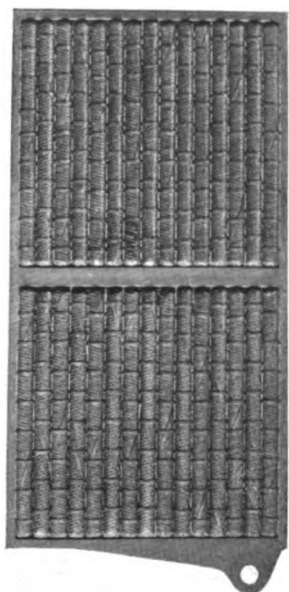


FIG. 9a.—EDISON POSITIVE PLATE FOR VEHICLE USE. ($\frac{1}{4}$ SIZE)

The tubes are made up of perforated, nickel-plated steel, wound spirally and double seamed, then filled in very ingenious machines, which introduce alternately small charges of nickel hydroxide and of metallic flake nickel, a ramrod descending after each charge to pack it tightly in place. The nickel flake is the result of months of development, and is made by alternately electroplating nickel and copper in extremely thin layers till a plate of reasonable thickness is produced; this is then cut into small squares and the copper chemically dissolved out, leaving the nickel flakes of extreme thinness. Each tube made up in this way constitutes a complete single unit, from which the larger units of commercial size are built up in much the same way as the negative plates.

The plates are assembled positive and negative alternately, with separators, consisting of hard-rubber pins, placed between to keep them from touching and the assembled element is placed within a nickel-plated steel can, which holds the caustic potash solution.

As the plates of an alkaline battery will not properly function in an alkaline carbonate solution, or even

in presence of a small amount of carbonate, it is necessary to seal the jars, so in the Edison battery we find the lid welded fast to the top of the jar. Exit for the gases generated is permitted thru a small check valve which excludes the atmosphere, with its contamination of carbonic acid.

As to characteristics, the Edison battery has some very distinctive ones, which fit it very well for certain classes of service, tho very much limiting its sphere of usefulness.

To mention its advantages first, if properly operated it will last for a very long time; that is to say, for a number of years with daily discharges. It is unquestionably more rugged than other types, owing to the fact that steel, of which it is chiefly built, is the ideal structural material. These two advantages, if unaccompanied by unfavorable characteristics, would undoubtedly put the alkaline cell much further ahead than we find it at the present time, and accordingly we have not far to look to find some very decided limitations. Without going into too many details, such as its high internal resistance, low electrical efficiency, injurious susceptibility to high temperature, the one reason above all others that makes most storage battery users entirely unfamiliar with the Edison cell is its peculiar behavior at low temperatures.

All batteries in general lose their capacity for storing energy with decreasing temperatures; in most types the capacity falls off about as the temperature does, so that at temperatures below zero they are still capable of performing their usual duties. The capacity of the Edison cell, however, falls off gradually as the temperature drops down thru the usual range until a certain critical point is reached, when it very suddenly drops off to almost nothing. This critical point varies with the rate of discharge, but for ordinary purposes may be taken at about 40° F., and below this the battery is to all intents and purposes inoperative.

Think for a moment of the conditions under which a self-starter for an automobile has to operate, generally standing over night, winter as well as summer, in an unheated garage, and you have at once the answer why the Edison battery has never even attempted to enter this, perhaps most extensive, field at present open to the storage battery.

The mean voltage of the Edison cell on discharge is about 1.2 and on charge about 1.64 at the five-hour, or so-called normal, rate. Its voltage efficiency (that is, the ratio of the mean discharge to mean charge voltage) is about 73 per cent.; its ampère-hour efficiency about 75 per cent., tho both these figures vary according to conditions. The watt-hour, or energy efficiency, under these conditions is about 55 per cent., but as the commercial charging of a battery is usually done from a line or bus of fixed voltage, which must at least equal the maximum of the battery, it follows that the voltage which must be paid for is considerably greater than the mean noted above.

The "commercial efficiency" is hence lower than would be calculated by averaging charge and discharge curves, and may be generally taken at about 50 per cent.

THE LEAD ACID CELL

As an example of a cell belonging to the fourth class, I would like next to draw your attention to the lead sulphuric type, the ordinary storage battery of commerce. The primary reaction consists in the formation of lead sulphate at the negative plate, and water

and lower state of oxidation, tho in the latter state it may enter into secondary action. As in the last case, the two active materials must both be stable in the electrolyte in all conditions, which precludes for negative purposes all the metals which are decomposed by the electrolyte.

While there may be other combinations than that of lead, lead peroxide, and sulphuric acid that fill these requirements, I think that as you try various ones you will invariably find there is some one of the conditions as outlined which cannot be met, so that the combinations, one after another, become eliminated.

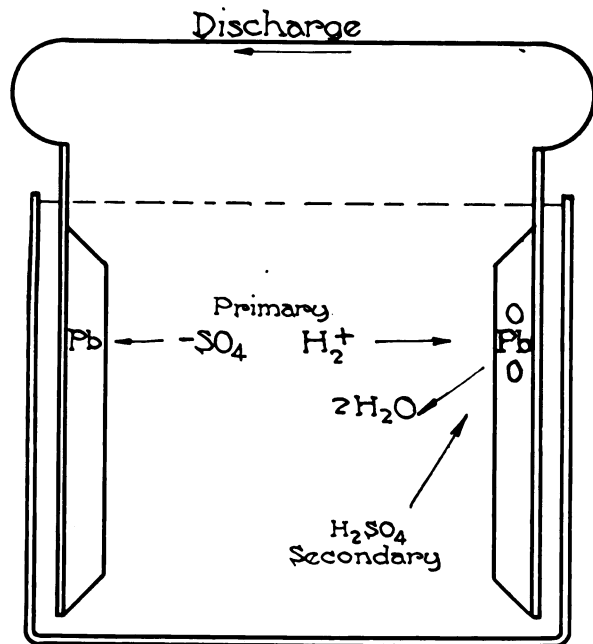


FIG. 10.—LEAD ACID CELL. RESULT OF DISCHARGE. PbSO_4 . PbSO_4 . $2\text{H}_2\text{O}$.

at the positive, in addition to which there occurs a secondary action at the positive, consisting in the formation of lead sulphate and water. The complete reactions are shown in Fig. 10.

Let us look for a moment at the possibilities of using other materials here. For the negative active material we require a substance that is a good conductor, that has a strong affinity for the active radical of the electrolyte, and that forms with it an insoluble or almost insoluble compound, and, as in the last case, it practically follows that this material shall be a metal. The function of the positive plate in this type is that of a depolarizer, since hydrogen, or possibly its equivalent as a metal, is pretty sure to be liberated there on discharge. In such a case the positive must contain oxygen, which is readily released, so that in the process little or no energy is absorbed to detract from that liberated by the energy-giving action on the negative. Practically the normal oxides do not fulfil this latter condition, and peroxides of one kind or another have to be used. The positive active material beside this requirement must be at least a fair conductor, and it must be insoluble in the electrolyte, in both its higher

BRIEF HISTORICAL SKETCH OF THE LEAD BATTERY

The lead storage battery of to-day exists in several distinct types, and as each is the survivor of many unsuccessful attempts, and as development has been gradual, it is convenient to treat it historically.

About the year 1860 Planté, experimenting with a number of electrolytic cells, placed a couple of lead plates in a vessel containing weak sulphuric acid, thru which, in series with a galvanometer, he passed an electric current. After the current had flowed for some time in one direction, he stopped it, and, bringing the two cell terminals together, was surprised to find from a reverse swing of the galvanometer, still in circuit, that the cell gave back some of the electrical energy that had been applied to it. Repetition of the experiment showed that the cell slowly but steadily gained in capacity for storing energy, while occasional reversals greatly accelerated the gain.

The explanation of the phenomenon as we now understand it is this: Metallic lead, when placed in sulphuric acid, is immediately attacked, with the formation of a thin skin of lead sulphate, which, being insoluble, protects the metallic lead inside and prevents further action. Electrolysis, however, converts the sulphate upon the positive to peroxide of lead and permits the sulphuric acid to work a little further into the metal beneath; and it is thus that the action is cumulative and the amount of lead in a porous or "active" state continually increases. Electrolysis affects the negative, however, merely in reducing the lead sulphate to metallic lead, so there is here no cumulative action, and hence occasional reversal is necessary to build up the thin skin of "active material" on both plates together.

Months of charge, discharge, and reversal were required to build up a layer sufficiently thick to make a battery of useful capacity. Hence other inventors set about to shorten this arduous process, known as "formation," and finally Faure, in France, and Brush, in America, about simultaneously discovered that they could apply to the plates a thick coating of lead oxide, made into a sort of putty-like paste with sulphuric acid, which, by means of a single slow charge, was converted into thoroly porous active material.

Subsequent improvements on Planté's process have shortened it until now it is about as quick and as cheap as Faure's process, so that at the present time both are successfully employed, the Faure very much the more extensively.

PLANTÉ AND PASTED TYPES COMPARED

The Planté and pasted types as now used differ very distinctively in their design, tho electrically the



FIG. 11.—TUDOR POSITIVE PLATE FOR MAIN LIGHTING. (1/2 SIZE)

difference is much less than would be expected. The Planté plate consists of pure lead, upon the surface of which there is "formed" a thin layer of "active material" having a thickness of the order of a few hundredths of an inch. The layer is necessarily thin

"Tudor" Positive Plate

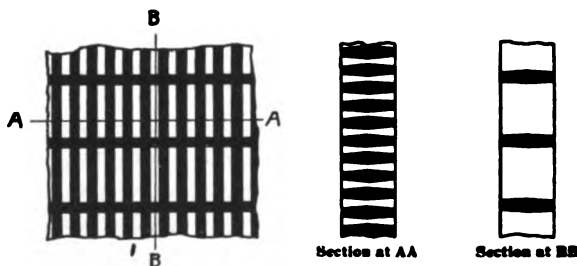


FIG. 12.—CROSS-SECTION OF TUDOR POSITIVE PLATE. (NOT TO SCALE)

in order to prevent its peeling off readily; hence a very large surface is required, and this is usually obtained by making the lead plates in the form of a number of parallel transverse leaves, as shown in Figs. 11 and 12.

The surface is increased by this construction, anywhere up to eight or ten times that of a plain sheet of equal superficial area.

The "pasted" (Faure) type, on the other hand, is

characterized by a relatively thick mass of porous active material, retained by an openwork grid or lattice of lead antimony alloy, as shown in Figs. 13 and 14.

Both types of plate can be used as either positive or negative, but certain characteristics make the one or the



FIG. 13.—EXIDE GRID.

other better suited to particular classes of service, as will appear hereafter.

NEGATIVE PLATES

The negative plate of a lead storage battery, at least theoretically, is quite a simple matter; the sponge lead which constitutes the active material has considerable

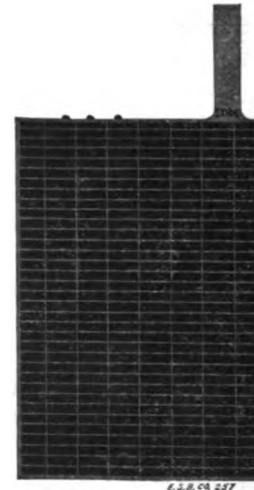


FIG. 14.—EXIDE POSITIVE PLATE FOR VEHICLE PROPULSION AND OTHER PORTABLE SERVICE. (1/2 SIZE)

mechanical tenacity and is therefore relatively easy to hold in place upon the skeleton frames or "grids" to which it is applied. There is no destructive action upon the lead antimony alloy of which these grids are made, and they may therefore be as light as methods of manufacture will permit. Fig. 13 shows a negative grid of the type which is now standard in the United States, and which is still best known under its original name of the "Exide." Fig. 15 shows a cross-section of the same grid, and shows how the active material occupy-

ing the interior spaces is locked in place so as to be both retained and protected, while Fig. 16 shows the finished plate, the active material filling all the interior spaces. This type of plate is used in sizes from about three square inches surface up to 500, and for

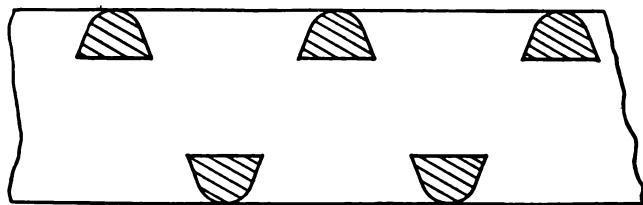


FIG. 15.—CROSS-SECTION OF EXIDE GRID.
(NOT TO SCALE)

every variety of purpose for which lead batteries are employed.

For some purposes, however, it is desirable to have a plate which will give the maximum possible life, consequent increased weight being a secondary con-

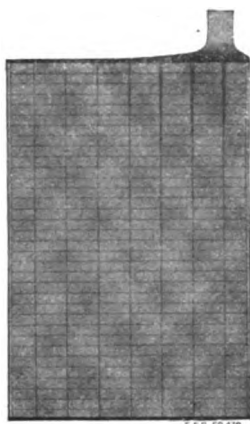


FIG. 16.—EXIDE NEGATIVE PLATE FOR VEHICLE PROPULSION, ETC. ($\frac{1}{4}$ SIZE)

sideration. To meet this requirement the "Box" negative shown in Fig. 17 is used. This plate may be considered as a development of the Exide type, inasmuch as the active material is held within two protecting



FIG. 17.—BOX NEGATIVE PLATE FOR STATIONARY SERVICE.
($\frac{1}{4}$ SIZE)

surfaces, which, in the case of the box plate, consist of finely perforated lead sheets, while in the Exide type they consist of parallel bars with relatively large openings between.

The Box plates are used almost entirely where long

life is the main consideration, but the greater weight of grid, with consequent greater cost, has caused them for most purposes to be superseded by the Exide type.

The grids of the Exide type are castings of antimony lead alloy, made as light as possible consistent with necessary mechanical and electrical conductivity. The Box grids are composite, consisting of perforated lead sheets, upon which are cast intersecting ribs, or bars, of antimony lead alloy which give the necessary strength; and each plate consists of two parts riveted together, with the active material enclosed between them.

While any oxide of lead may be used for the active material of negative plates, a long process of elimination has finally resulted in the universal adoption of litharge for this purpose, applied as a putty-like mass, made by mixing the litharge with dilute sulphuric acid.

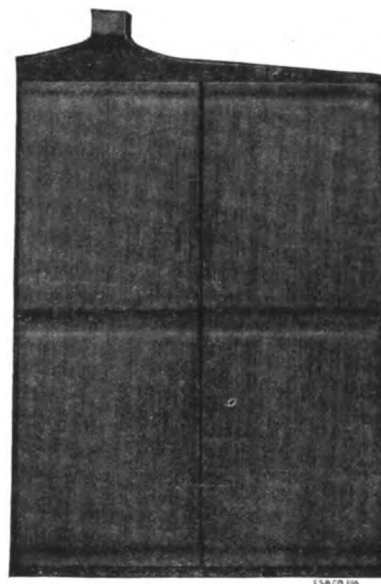


FIG. 18.—ROLLED NEGATIVE PLATE FOR TRAIN LIGHTING.
($\frac{1}{4}$ SIZE)

An initial charge, or "formation," converts the litharge into metallic sponge lead, giving the plate a characteristic light slate color.

There are still a few Planté negatives used, in this country only, such a one being shown in Fig. 18, but their weight and cost are against them, and they are to-day almost a thing of the past.

POSITIVE PLATES

The positive plate offers a more complicated problem, chiefly because lead peroxide, under the conditions which exist in a storage battery, does not possess much sustained mechanical strength, but gradually becomes soft, and in time is loosened from the plate, falls to the bottom of the cell, and thenceforward plays no useful part in the life of the battery.

To maintain the capacity over an extended period of charges and discharges three distinct methods are employed.

PASTED POSITIVE

In the pasted type of plate, when new, only a part of the lead peroxide is available for entering into the chemical reactions of the cell, as the acid penetrates only partially into the interior of the mass. As the surface wears away the action penetrates farther in, and thus the inner part of the mass acts as a reserve and maintains the capacity for a number of cycles, roughly stated at 300 to 500. By making the plate very thin, say of the order of one-eighth inch, the reserve of active material is cut down to a minimum, hence giving a plate of maximum capacity per unit of weight, but of relatively shorter life.

Positive plates of the pasted type are universally employed where lightness, or maximum capacity for given weight, is the primary consideration, and the correct balance between thick, heavy plates of long life and thin, light ones of shorter life, to meet special conditions, is a continual problem to the designer. The general trend of modern practice, however, is toward much thinner plates than were thought practicable a few years ago, a thickness of three thirty-seconds inch being quite common.

The Exide type of positive plate, which has become standard thruout the United States, and largely so in Europe, is practically identical with the negative shown in Figs. 13 and 15, so far as concerns the grid; it is, however, a little stronger and heavier in order to withstand the slight "forming" action to which all positive grids are subject. The active material which is applied to it consists of red lead, mixed usually with sulphuric acid or ammonium sulphate, and is converted by the initial charge or "formation" into lead peroxide, having a characteristic chocolate color. Fig. 14 shows a finished positive plate of this kind. This general type, having two sets of thin, usually parallel, bars upon the two surfaces of the plate, with the active material enclosed between them, is almost the sole survivor of countless designs which have been tried, and is made in largest and smallest sizes, in all thicknesses, and with all sorts of varieties as to details of proportions and dimensions.

PLANTÉ POSITIVE

The Planté plate is also subject to the continual, slow washing away of its lead peroxide, but the original layer is more durable than the peroxide made from red lead, so it lasts a considerable time in spite of its thinness. Moreover, all the while that the original layer is disintegrating and falling away, the electrolytic action is penetrating farther into the metallic lead of the plate, in the manner of the Planté formation, and thus there is a balance between loss and gain, and the capacity of the plate is maintained for a long period, say about two to three times as long as in the case of the pasted plates. For effecting this extended life, however, there is required a large reserve of pure

lead; and, as it actually works out in practice, the Planté plates are materially heavier, say 100 to 200 per cent., than the pasted plates of equal capacity.

Figs. 11 and 12 show a Planté type of plate known in this country as the "Tudor," used largely in Europe, and consisting of an integral one-piece casting; while

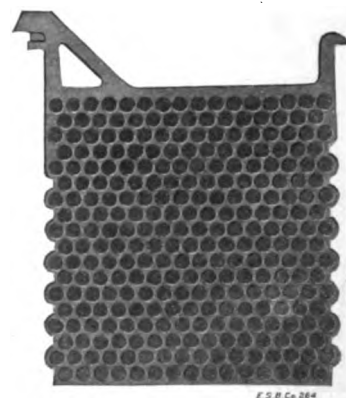


FIG. 19.—MANCHESTER POSITIVE PLATE FOR STATIONARY SERVICE. ($\frac{1}{8}$ SIZE)

Fig. 18, tho actually a negative, may be used as illustrating the Gould type, made from rolled sheet lead, by a spinning process. The Willard positive is also of the same general appearance, but is made by grooving a sheet of lead with a special tool which turns up a series of close-lying leaves upon its surface.

In this country and in England a modified Planté

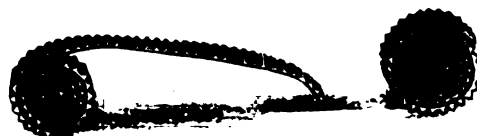


FIG. 20.—MANCHESTER BUTTON. ($\frac{1}{32}$ SIZE)

plate, known as the "Manchester," has largely superseded all of the above, chiefly on account of its superior mechanical construction. The Planté plate is made of pure lead, because this metal is attacked by the electrolytic action at about the right rate to replace the loss of lead peroxide; but pure lead is very soft, hence these plates are much subject to buckling and breaking. The



FIG. 21.—SECTION OF MANCHESTER PLATE. ($\frac{1}{32}$ SIZE)

Manchester plate (Fig. 19) differs in that a rigid grid, or frame, of antimony-lead alloy furnishes mechanical strength, while small, pure lead, spirally wound "buttons" (Fig. 20) inserted in holes of the grid (Fig. 21) furnish the active material which performs the electrochemical function of the plate.

The combined mechanical and electrical endurance of this type of plate has given it a very broad field of application; its weight, roughly triple the pasted type, and its consequent cost, constituting its chief limitations.

IRONCLAD TYPE

During the past five years a third type of positive plate has come into prominence in this country, founded on the principle first successfully developed by Philip-

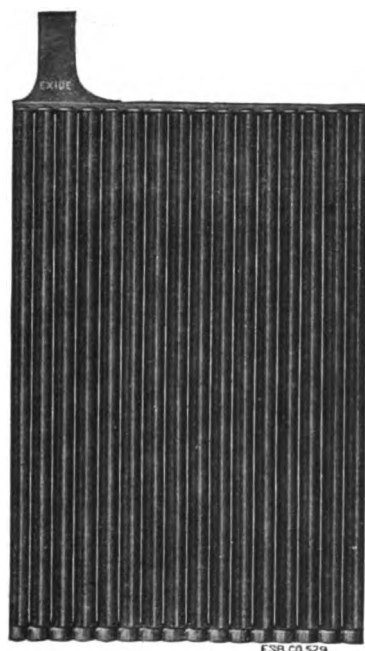


FIG. 22.—IRONCLAD POSITIVE PLATE FOR VEHICLE PROPULSION AND OTHER PORTABLE SERVICE. ($\frac{1}{4}$ SIZE)

part, in France, about the year 1898. This plate, known as the "Ironclad," is shown in Fig. 22, and differs from those heretofore discussed in that a porous exterior envelope retains the active material in place, so that the

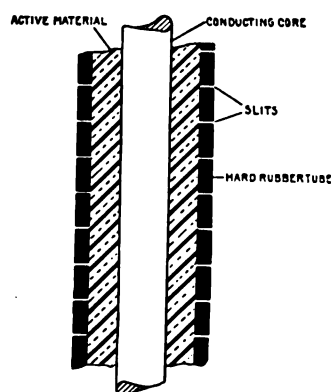


FIG. 23.—IRONCLAD TUBE SECTION. (TWICE ACTUAL SIZE)

large reserve necessary with other types is here unnecessary.

The plate consists of a number of cylindrical pencils, one of which is shown in cross-section in Fig. 23; a central lead antimony core furnishes support and conductivity for the surrounding mass of active material, itself again enveloped by the perforated rubber tubes

(Fig. 22). The perforations in the tube consist of thin saw cuts of the order of $\frac{1}{100}$ inch wide; and, while this envelope does not entirely prevent the wastage of active material, it increases its life about two or three times.

The life of the Ironclad plate is thus about the same as that of a Tudor or Manchester plate, while its capacity-weight ratio is about on a par with the pasted types.

With the Ironclad plate, loosening and washing out of the active material is reduced to a minimum, and, contrary to what might be expected, the protective rubber tube offers but very slightly increased resistance to the passage of the electric current. Owing to manufacturing considerations, however, it is impracticable to reduce the size of the tubes below a certain point, and hence the capacity is not so high per unit of weight as that of the thinnest of the Exide types.

This type of plate, in conjunction with an Exide negative of suitable thickness, is fast becoming standard in this country in all portable service where durability is a prime factor.

SEPARATORS

Thus far we have limited ourselves to the question of the plates of the lead battery; but, tho they undoubtedly constitute the greater problem of storage battery design, yet the manner in which they are as-

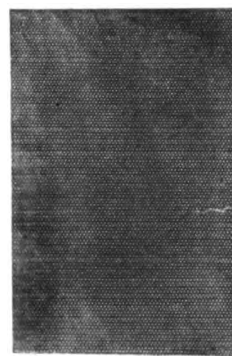


FIG. 24.—PERFORATED RUBBER SEPARATOR. ($\frac{1}{4}$ SIZE)

sembled is almost as important as the design of the plates themselves; and next in order of importance come the "separators." Considerations of space, weight, and electrical resistance all demand that adjacent positive and negative plates be maintained as close together as possible, yet without touching anywhere. To fulfil these requirements, spacers or separators of some sort are inserted between them. Here again countless schemes have been tested out, but to-day practically only two types have survived, and these often used in conjunction.

The older of the two is the perforated rubber separator, shown in Fig. 24, as a flat sheet of perforated hard rubber, and often, when used alone, provided with a series of parallel ridges on one side, to provide sufficient acid space between plates. When so used, however, even tho the holes be small, "trees" of lead are very apt to develop on the negative plates, which in

time find their way thru to the positive and cause short-circuits.

The perforated rubber separator used by itself is therefore not satisfactory and has been almost entirely replaced by the wood separator, examples of which are shown in Figs. 25 and 26. In the one case the separator is a veneer about 1/16 inch thick, with split wood

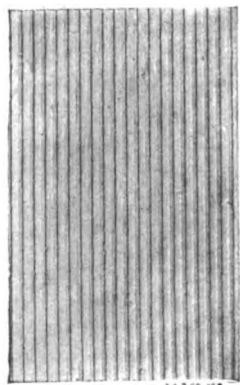


FIG. 25.—GROOVED WOOD SEPARATOR. ($\frac{1}{4}$ SIZE)

dowels slipped over it to give the necessary space between plates; in the other it is made of a thicker piece, grooved. The distinctive feature of the wood separator is that it is not perforated, with the result that short-circuits seldom get thru it, while its electrical resistance is nevertheless almost negligible.

In many cases the grooved wood separator and plain

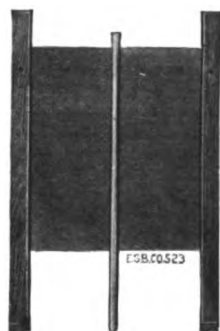


FIG. 26.—FLAT WOOD SEPARATOR WITH DOWELS.

perforated rubber are used together, the flat of the wood against the negative, the rubber against the positive plate, this making an excellent combination, used in most of the vehicle propulsion and many other portable batteries.

The flat veneer with split dowels is used chiefly in large stationary batteries, where the grooving would constitute too great a wastage of wood.

CONTAINERS

The vessels which contain the complete element—plates, separators, and acid—are of three different kinds: hard-rubber jars, where lightness and ruggedness are required, that is, for all kinds of portable service; glass jars for stationary service in the smaller sizes; lead-lined wooden tanks for the larger stationary installations.

ELECTROLYTE

The electrolyte in lead batteries is dilute sulphuric acid, of the highest available purity and of strength varying according to conditions. Where space and weight are of utmost importance, stronger acid, about

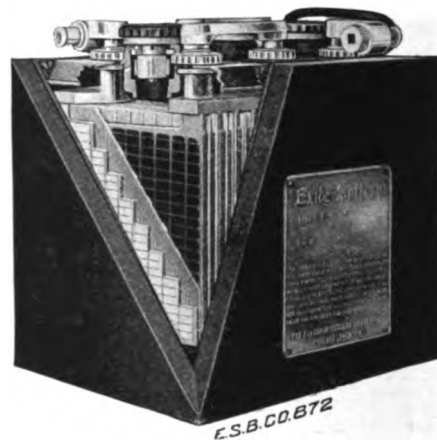


FIG. 27.—AUTOMOBILE STARTING BATTERY, ONE CELL CUT AWAY TO SHOW INTERIOR. (ABOUT $\frac{1}{4}$ SIZE)

1.280 specific gravity, is employed, but where these items are non-essential a greater bulk of weaker acid, say 1.200 specific gravity, answers better, in that it causes less loss from local action, especially on the negative plates.



FIG. 28.—IRONCLAD EXIDE CELL FOR VEHICLE PROPULSION AND OTHER PORTABLE SERVICE. (ABOUT $\frac{1}{4}$ SIZE)

GENERAL ASSEMBLY

So much variety exists in the details of assembly employed by different manufacturers and for different purposes that it will be possible to mention only a few of the controlling factors, and to give a few illustrations of complete cells (Figs. 27, 28, 29, and 30).

In all present-day designs, positive and negative plates are placed alternately side by side, all of like polarity being firmly united into "groups" by means of "lugs" which project from the upper corners. Figs. 31 and 32 show a positive and a negative group as used in the small auto starting battery of Fig. 27; and these illustrations also show the general manner in which the plates are united, by a lead welding process, to the connecting straps which form the terminals of the cell.

The corrosive action of the acid electrolyte makes this lead welding necessary, and in most instances it is applied, not only in fastening the plates to the cell terminals, but also in fastening adjacent cell terminals together, so that there is a solid metallic contact from cell to cell thruout the whole battery.

Between the plates, and thus keeping them apart, lie the separators; the whole element so proportioned as to fill the container, tightly in portable batteries, somewhat loosely in stationary ones.

Because of the continual slow erosion of active material from the plate surfaces there must always be a free space under the bottom of the plates, so that they shall remain clear of the dislodged matter. The plates are therefore either supported upon ridges projecting upward from the bottom of the jar (Fig. 28) or are suspended from the top of the jar (Fig. 29) or from the lid (Fig. 27) or in some equivalent manner.

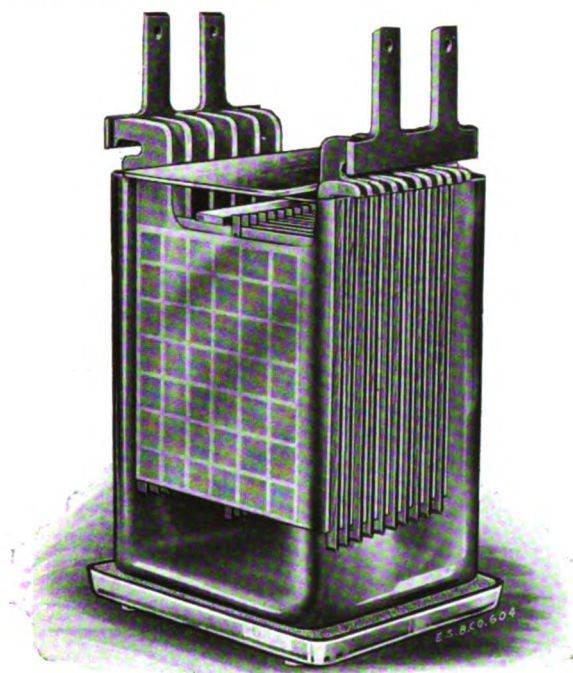


FIG. 29.—STATIONARY CELL IN GLASS JAR.

Tight covers for the containers have to be provided only for portable service; stationary cells are generally left open for ready inspection and access.

CHARACTERISTICS

The two useful values furnished by a battery are voltage and current, and, while much variation as to both exists in different kinds of cell, a few curves will give a general idea of performance.

Fig. 33 shows, in the two upper curves, the voltage of a stationary type of lead cell at its eight-hour rate, both on charge and discharge. The principal point to notice is that the voltage is held nearly constant between 1.9 and 2.0 during the greater part of the discharge, and that, as the end approaches, it drops more rapidly, so that there is a fairly definite limit to the useful discharge, in

this particular case at about 1.7 volts. Similarly, on charge the voltage holds nearly constant at 2.2 and 2.3 for the greater part of the time, and then quite rapidly rises to about 2.6, after which there is little further change. When the voltage fails to rise further, it is an

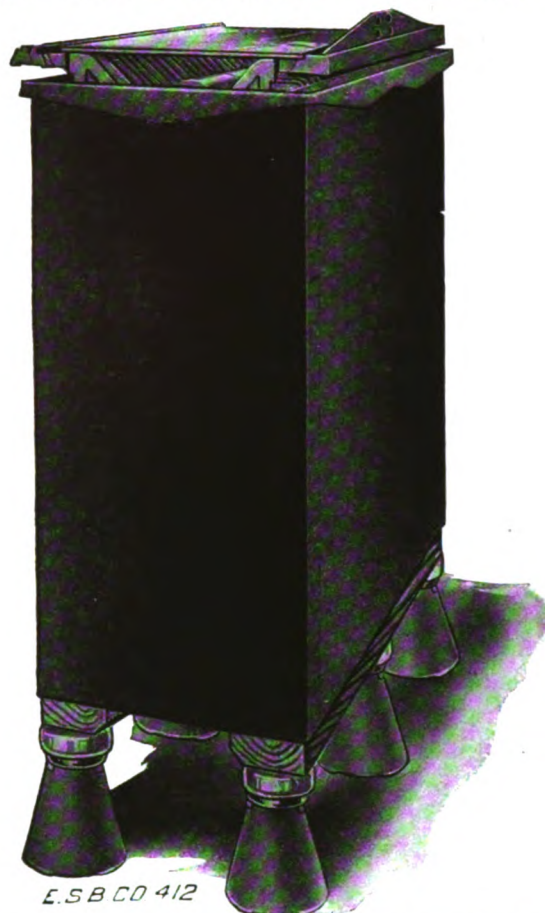


FIG. 30.—LARGE STATIONARY CELL IN LEAD-LINED WOOD TANK.
($\frac{1}{3}$ SIZE)

indication that the cell has absorbed all the charge it can, and that the lead sulphate produced on discharge has been all converted into lead peroxide and metallic lead upon the respective plates.

It is interesting to note that the ratio of the mean dis-



FIG. 31.—POSITIVE GROUP OF PLATES FOR AUTO STARTING.
(ABOUT $\frac{1}{4}$ SIZE)

charge voltage (1.89) to that of the charge (2.32) is about 81.5 per cent., which figure represents the volt efficiency.

Owing to the fact that during charge the reactions never take place quite according to theory, some wastage always occurs in the shape of liberated gas, and the charge must always exceed the discharge. As shown in Fig. 33,

the charge lasts an hour longer, making the ampère-hour efficiency 89 per cent.

The actual watt-hour of energy efficiency, being the product of these two, is therefore about 72.5 per cent. If this particular battery had been charged from a bus of fixed voltage, however, as is usually the case in commercial practice, that voltage must have equaled the maximum (2.65), with the result that the "commercial" volt-



FIG. 32.—NEGATIVE GROUP OF PLATES FOR AUTO STARTING.
(ABOUT $\frac{1}{4}$ SIZE)

age efficiency would have been but 75 per cent. and the watt-hour efficiency about 66 per cent. On the other hand, if charge and discharge follow each other rapidly and for short intervals, both variation of voltage and wastage due to evolution of gas are much reduced, so that actual efficiencies approaching 90 per cent. are sometimes realized.

The general shape of the curves of Fig. 33 is characteristic of all lead cells, and even actual values vary sur-

prisingly little thruout the ordinary ranges of working and with various types of cells. One of the chief factors which does, however, affect voltage is current rate, and an idea of the variation which may be thus produced can be gathered from the three upper curves of Fig. 34,

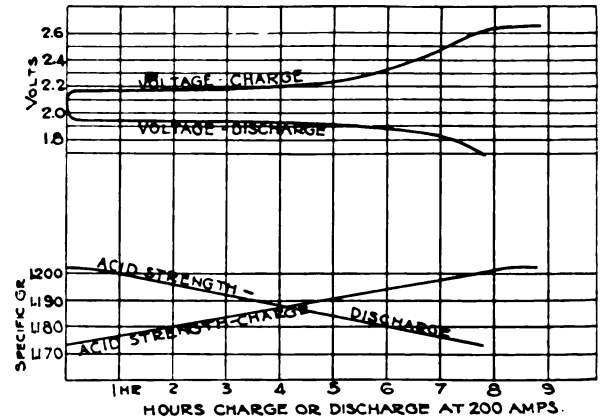


Fig 33

which give initial, mean, and final voltage thru a wide range of discharge rate.

One of the most valuable characteristics of the lead battery is its extremely low internal resistance, for it is this which gives it the property of discharging at enormously high current rates, when required, with but slight diminution of voltage.

But, while the voltage is well maintained even at very

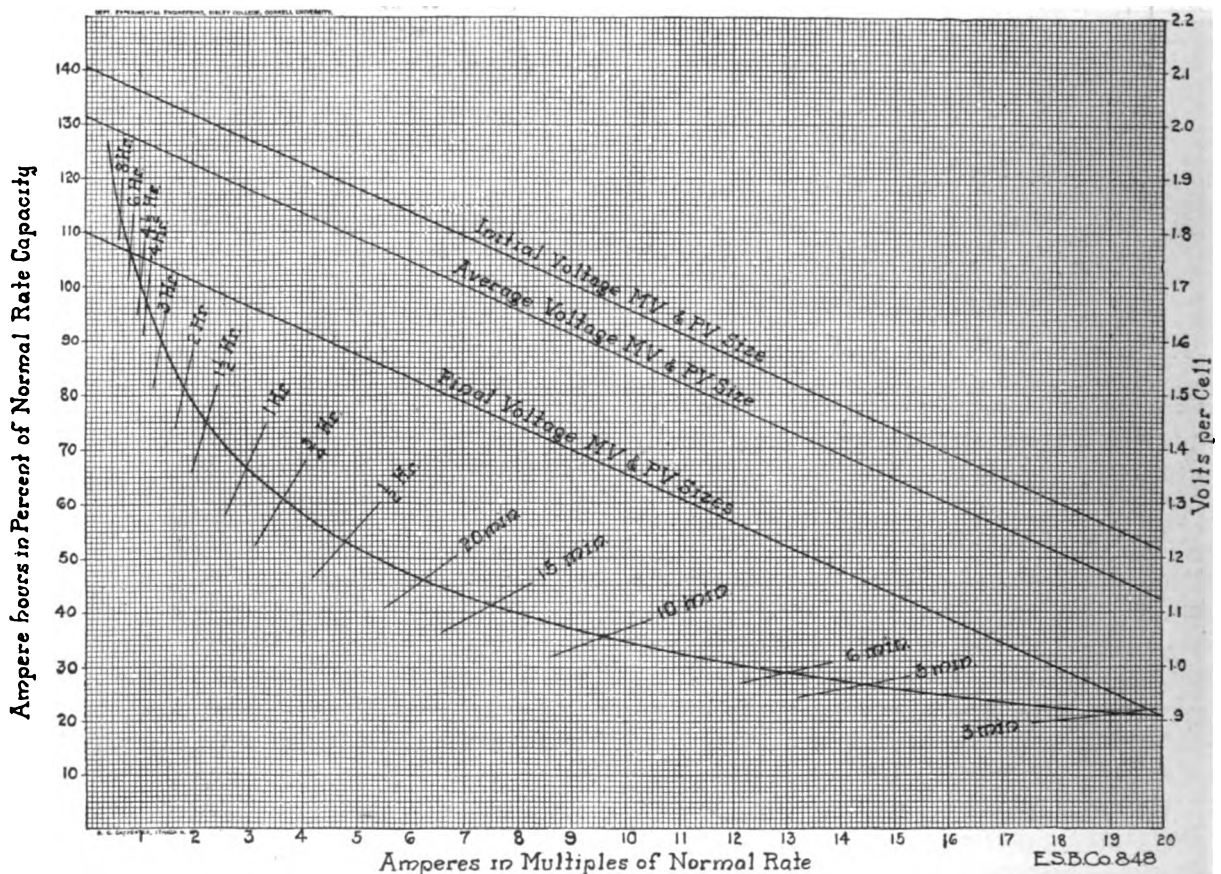
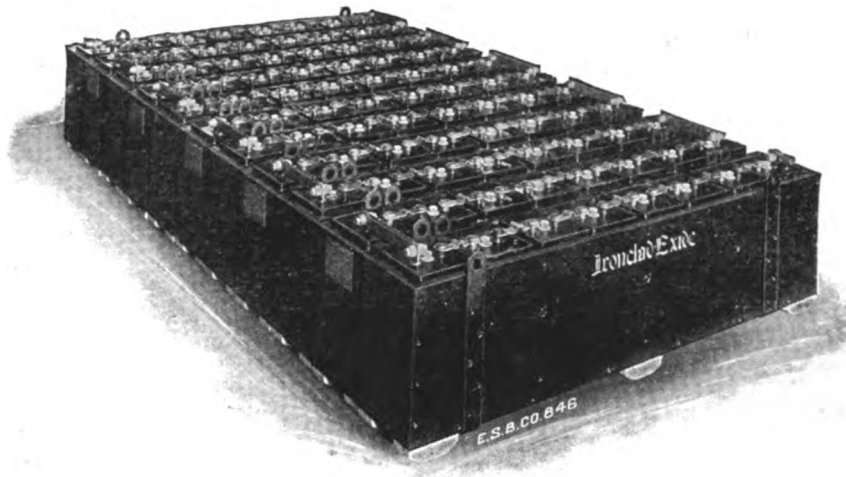


FIG. 34.—LOWER CURVE, VARIATION OF CAPACITY WITH DISCHARGE RATE. UPPER CURVE, VARIATIONS OF VOLTAGE WITH SAME

NOTES ON THE ELECTRIC STORAGE BATTERY



ELECTRIC LOCOMOTIVE BATTERY, CONSISTING OF CELLS, 17 PLATES, EACH, CAPACITY 56 AMPÈRES FOR $4\frac{1}{2}$ HOURS, OR 150 AMPÈRES FOR 1 HOUR.



CENTRAL STATION "STAND BY" BATTERY, CONSISTING OF 150 CELLS, EACH WITH 167 "H" EXIDE PLATES. CAPACITY—12,450 AMPÈRES FOR ONE HOUR AT 250 VOLTS; INTERNAL RESISTANCE OF WHOLE BATTERY—0.002 OHM.
Illustrations—Courtesy of Electric Storage Battery Company.

high rates, this does not hold true of the ampère-hour capacity, which falls off regularly as the current rate rises. This characteristic also is illustrated in Fig. 34, the lower curve, based on the capacity which the cell can deliver at constant current rate in $4\frac{1}{2}$ hours, this being called 100 per cent. Reference to this curve shows that if the

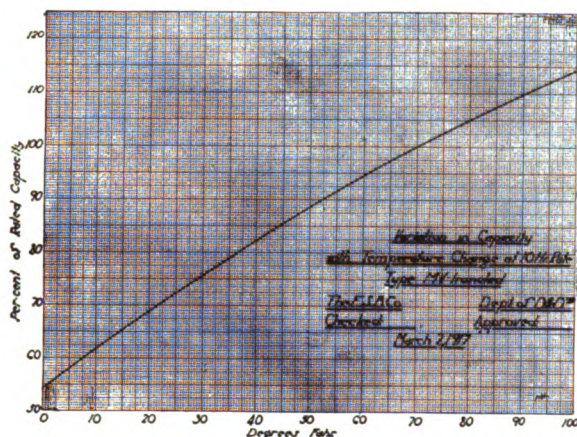


FIG. 35.—EFFECT OF TEMPERATURE ON CAPACITY.

current be trebled it can be maintained for only one hour, or the capacity has been reduced to 66 per cent. If the current be increased five-fold, the capacity becomes 50 per cent.; and, on the other hand, if the current be halved, the ampère-hour capacity becomes 120 per cent.

Reference to Fig. 9 shows that during charge and

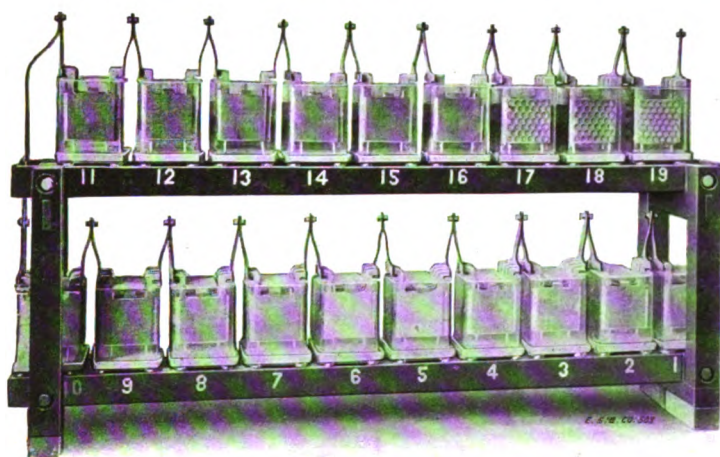


FIG. 36.—SMALL STATIONARY BATTERY INSTALLATION AS USED FOR TELEPHONE EXCHANGES, ETC.

discharge sulphuric acid is alternately liberated and absorbed by the plates, and hence indicates that the strength of the electrolyte changes with the condition of the cell. Fig. 33 illustrates the change of acid thus actually occurring with discharge. The change in strength of acid is dependent upon the acid volume,

and, as this varies widely in different types of cell, no characteristic values can be given for it, but, if required, it must be accurately ascertained for a particular case. Since the acid strength is readily measured by a hydrometer, and as its change is a fundamental part of the reaction of the cell, it forms one of the best means of ascertaining the exact state of charge or discharge. Especially it is valuable as a means of knowing when the charge is complete; for so long as the specific gravity rises, acid is still being given off by the plates; when it rises no further, this shows that the plates have given off all they possess, and are consequently completely charged. This feature is extremely useful, because it is independent of original strength of acid, size, or design of cell, so that it is a general axiom of the lead cell, with few modifications and no exceptions, that when, and not until, the specific gravity stops rising, the charge is complete.

It has been mentioned that temperature affects the discharge capacity of the lead cell, and the extent of this effect is shown graphically in Fig. 35. Reference to this curve shows the capacity at 0° F., about 54 per cent. that at 70°, while at 100° it is 114 per cent.

USES OF BATTERIES

Storage batteries to-day find innumerable applications, owing broadly to the fact that they offer the most convenient known means of storing energy, in such form as to be immediately available, in whatever amount required, and in the form of electric current, which is readily applied to practically all purposes. They are, when given reasonable care, extremely reliable and have fair efficiency and durability. With hardest use, consisting of daily charge and discharge, driving electric vehicles, the lightest types will last about a year; while in the same service the more modern type will last about two to three times as long.

Stationary batteries, where the service is not so severe, and where heavier types may be used, last much longer—say anywhere up to ten or more years.

The main limitation to their use is weight, but this does not prevent a very large sphere of usefulness, and indeed it is surprising to know that a modern battery, as used for auto-starting, for instance, can store sufficient energy to lift itself about 30,000 feet high.

Improvements in design and in operation during the past ten years have greatly advanced the status of the storage battery, and there is every reason to believe that during the next ten years these improvements will continue, with a much further growth of usefulness to mankind.

EARLY CHEMICAL MANUFACTURING IN PHILADELPHIA¹

BY SAMUEL P. SADTLER

THE earliest efforts at chemical manufacturing in Philadelphia, as in other parts of the American Colonies, were undoubtedly due to the feeling of the colonists that they must free themselves from the oppressive trade regulations of the mother country. We read in the sketch of the career of one of the pioneers of Philadelphia chemical industry the following:

"The earliest efforts of the colonists—the manufacture of coarse, woolen fabrics in 1719—so excited the jealousy of Great Britain that the English Parliament declared 'that the erecting of factories in the colonies must be discouraged at all cost,' so every enterprise met with great opposition. It was not, however, until 1774 that Pennsylvania became so aroused by English oppression of her industries that a convention of delegates from all the counties was held in Philadelphia. Joseph Reed was president, Jonathan B. Smith, John Benezet and Francis Johnston were secretaries. The convention earnestly enforced the strict observance of non-importation agreements and, to provide against the inconvenience which might result, recommended the preservation of sheep until they were four years old, and the immediate establishment of the manufacture of woolens, salt, saltpetre, iron, nails, copper in sheets and kettles, malt liquors and gunpowder especially, 'as there existed a great necessity for the latter, particularly in the Indian trade.' The convention advised the exclusive use of home manufactured articles and urged that associations be immediately formed for the encouragement of all domestic productions."

This feeling only came to a head about the time of the beginning of the Revolutionary War. Prior to that, in the Colonial period, the production of potashes and lime, some attempts at the extraction of salt from brines, tentative efforts at the making of gunpowder, and domestic utilization of the potashes in soap-boiling about comprised the chemical manufacturing industry. Of these the most important was the manufacture of potash from wood-ashes. Scharf and Westcott's "History of Philadelphia" states that in 1772 the value of the potashes manufactured in America was £50,000.

As before stated, the oppressive trade regulations of England acted as an impelling force in the establishment of chemical industries. Thus the exportation of powder and its materials from England was prohibited by an order of Council of October 19, 1774, so that the American Colonies were made dependent on other sources for their supply.

"The Continental Congress in various ways encouraged the erection of powder mills and also the production of nitrate of potash. Congress in 1775 published a manual giving directions for making saltpetre, and about the same time the 'Committee of the City and Liberties' erected a large saltpetre works on Market Street for the double purpose of making saltpetre and also to instruct such as were willing to

engage in the making of this very necessary article for the powder mills.

"The manufacture of gunpowder was very extensively carried on during the Revolution in nearly all of the American Colonies. A very large proportion of this powder, however, was made in Pennsylvania. Philadelphia was among the first places in which powder mills were successfully operated.

"Early in the Revolution a public powder mill was established in or near Philadelphia by the Assembly, while Congress opened, and for some time operated, what was known as 'The Continental Powder Mill.' Congress also offered advances to such persons as would be willing to establish powder mills within 50 miles of the city of Philadelphia, and this offer was taken advantage of by many who subsequently supplied a liberal proportion of the powder used in the Continental Army."

But to come back to the efforts of the colonists to free themselves in other lines from dependence on the mother country, we read in the sketch of the career of Samuel Wetherill, from which we previously quoted:

"Samuel Wetherill was one of the promoters and managers of the 'United Company of Pennsylvania for the establishment of American Manufactures.' He embarked his whole soul in the business, and in 1775 set up at his own dwelling house in South Alley, then called Hudson Square, now Commerce Street, a factory for jeans, fustians, everlastings and coatings (Fustian is a cloth, the warp of which is linen and the woof thick cotton; it derived its name from Fusht, a town on the Nile where it was first made). This business was just for spinning and carding and did not necessitate any heavy machinery, but in order to prepare these goods properly it was necessary to have them dyed. There being no dyers in Philadelphia equal to the task, Samuel Wetherill was obliged to undertake this branch of the business also. His house on South Alley is described as being of two frames, which I suppose means what we would call a double house, and he was probably able to turn one frame into a factory and let his family live in the other. However that may be, a little inconvenience more or less in those days did not matter, where all were working together for the common good and for the highest principles. . . . So it was that Samuel Wetherill, who started as a carpenter, became a weaver, then chemist, etc., and when the war broke out he did not scruple about entering into a contract with Congress to furnish clothes for the patriot troops, being a patriot himself; and it is said that his timely shipment of supplies to Washington's little army at Valley Forge saved it from disbanding. This, his allegiance to his country, and his expressed approval of bearing arms for its defense, were the cause of his being 'dealt with' by the Society of Friends and cut off from religious communication and fellowship with them. Thereupon he and a few others who had publicly taken the oath of allegiance to the American cause started the Society called the 'Free or Fighting Quakers.'"

"Probably the first to inaugurate the manufacture of chemicals, as such, in this country, was the firm of Christopher, Jr., and Charles Marshall, sons and successors of Christopher Marshall, an early druggist and one of the original 'fighting Quakers' of Philadelphia. This firm had, as early as 1786, entered quite extensively into the business of making muriate

¹ Courtesy of the *Journal of Industrial and Engineering Chemistry*.

of ammonia and Glauber's salt. The factory is described by Watson, in his 'Annals of Philadelphia,' as being a grim and forbidding-looking building on Third Street near the stone bridge over the Cohocksink Creek. This firm is said to have developed an annual output of upwards of 6000 pounds of muriate of ammonia: quite an achievement for that time."

Let us now take up the beginnings of the manufacture in Philadelphia of one of the fundamentally important chemicals, *viz.*, sulfuric acid. This substance is recognized as the basis of all chemical industries and its manufacture must precede that of most other chemicals. The theory of the lead-chamber process was already understood by chemists, by the middle of the eighteenth century. Ward had made it in England in 1740 on a large scale in glass vessels, and Dr. Roebuck first used leaden chambers instead of glass in Birmingham in 1746. The first lead chamber was erected in France at Rouen in 1766.

Mr. John Harrison, the son of Thomas Harrison, a member of the Society of Friends, was an early Philadelphia druggist who had completed his education by spending two years in Europe, in part under the instruction of Dr. Joseph Priestly, the famous English chemist. Upon his return he began, in 1793, the manufacture in Philadelphia of various chemicals, and notably of sulfuric acid. He had at first a lead chamber capable of producing 300 carboys of acid per annum, and his laboratory at this time was on the north side of Green Street, west of Third. In 1804, he established a new factory at Second and Huntingdon Streets, near Frankford Road, Kensington, but continued for a time the work on Green Street. In 1807 he built what was for that time quite a large lead chamber; it was 50 feet long, 18 feet wide, and 18 feet high, and capable of making nearly 500,000 pounds of sulfuric acid annually, the price of which was then as high as 15 cents per pound.

"As is well known, acid produced in lead chambers is not the Oil of Vitriol of commerce, and the only method known at that time to concentrate it to the required strength was by boiling it in glass retorts—a very precarious and dangerous process. The constant breakage of the glass largely increased the cost of the concentrated acid and the dangers of the work. To obviate this great trouble Mr. Harrison, in 1814, introduced the use of platinum for the manufacture of sulfuric acid, for the first time, at least in this country. In the previous year, 1813, Dr. Eric Bollman, a Dane, had come to Philadelphia. Dr. Bollman was familiar with the metallurgy of platinum, and a highly scientific man. He brought with him from France Dr. Wollaston's method for converting the crude grains of platinum into bars and sheets. About the first use that Dr. Bollman made of these platinum sheets was the construction, early in 1814, of a still for the concentration of sulfuric acid for the Harrison works. It weighed 700 ounces, had a capacity of 25 gallons and was in continuous use for 15 years. This early application of platinum for such purposes was highly characteristic of the sagacity and ingenuity of the American manufacturer. At the time the use of this rare metal was a novelty in Europe and known only to a few persons and certainly entirely unknown in this country. It follows, therefore, that Mr. John Harrison was not only the earliest successful manufacturer of sulfuric acid

in America, but the first in this country to concentrate it in platinum."

Farr and Kunzi were next in Philadelphia to follow the lead of Harrison in making sulfuric acid, which it is stated they did in 1812, and shortly thereafter Wetherill & Bros. also began the manufacture of sulfuric acid on the east bank of the Schuylkill River. Charles Lennig, the founder of the present firm of Charles Lennig & Co., Inc., also began the manufacture of sulfuric acid in 1829, Rosengarten & Sons shortly thereafter, and Carter & Scattergood in 1834 also were early manufacturers of sulfuric acid.

Nitric acid, under the name of *aqua fortis*, is mentioned in Scharf & Westcott's "History of Philadelphia" as made by Christopher Marshall, Jr., a Philadelphia druggist at the close of the last century. A communication from Mr. Thomas Skelton Harrison says his grandfather, John Harrison, began to make both nitric and muriatic acids in 1804. Carter & Scattergood had it on their list of manufactures in 1834. Muriatic acid is also mentioned as made by this latter firm in the year 1834, as were tartaric acid and citric acid.

MANUFACTURE OF PAINT COLORS

We have here another record of which Philadelphia may be proud. We have already referred to the energetic work of Samuel Wetherill in starting American lines of manufacture just prior to the opening of the Revolutionary War. About 1789 he began the manufacture of white lead in Philadelphia and persisted in it, despite great efforts made on the part of the importers to hinder him by underselling and misrepresenting him. The first white lead factory of Samuel Wetherill & Sons was built in 1804 at the corner of Broad and Chestnut Streets, but it was burned down a few years later, and in 1808 they erected a new factory at Twelfth and Cherry Streets.

"His son, Samuel Wetherill, Jr., was the active man of the concern, and assisted his father in all business matters. The enforced experience which was pressed upon them during the Revolution concentrated their attention upon the manufacture and sale of chemicals, and they went into the drug business. In 1785 Samuel Wetherill & Son were located in Front Street above Arch. Here, for many years, 'Wetherill's drug store' was an old landmark, and the place at which sons and grandsons were brought up to the business. The Wetherills were the pioneers in the manufacture of white lead. They established it before the year 1790. They erected extensive white lead works near Twelfth and Cherry Streets, which were burnt down in 1813, but afterwards rebuilt.

"The fire which destroyed the white lead works proved to be incendiary and started by a young English officer the day before he sailed for England.

"In October, 1811, Samuel Wetherill, Jr., obtained patents for a new mode of washing white lead and for screening and separating metallic from corroded lead in the process of making red lead, and using the first machine ever used for manufacturing purposes in the United States. This method has been generally adopted and used by all makers of lead.

"The name of the first white lead firm was Samuel Wetherill & Son, Samuel Wetherill, Jr., evidently being the active member. After his father's death in 1816, Samuel

Wetherill, Jr.'s, sons joined in the business and the firm became Samuel Wetherill & Sons. After the death of Samuel Wetherill, Jr., in 1829, it became Wetherill Brothers. The store of the firm was at 65 N. Front Street; the warehouse and mill of the old establishment were on Coomb's Alley, back of Second Street.

"When the residence part of the city spread to Twelfth and Cherry Streets, Samuel Wetherill, having bought ten acres of land on the bank of the Schuylkill River below Chestnut Street, moved there in 1847; his sons (Wetherill and Brother) built the white lead and chemical works and continue to this day."

John Harrison also began the manufacture of white lead in 1806. The firm of Mordecai & Samuel N. Lewis, which afterwards became John T. Lewis & Brothers, also began the manufacturing of white lead in 1812, making three Philadelphia firms manufacturing paint colors at that time. These three earliest manufacturers of white lead and paint colors or their lineal successors have continued in business to the present time, for considerably over a century, and have done much to give Philadelphia its long-continued prominence as a chemical manufacturing centre.

"Chromates were probably first made in Baltimore, tho as early as 1816 a Mr. Wesener, a German chemist, had established himself in Philadelphia, in the neighborhood of Broad and Cherry Streets, where he made chrome salts and chrome pigments in considerable quantities. Being nearer the source of supply of the raw material, the Baltimore manufacturers had a decided advantage, so much so that before the middle of the last century the business had drifted back to that city."

The manufacture of varnishes followed that of paint colors. Christian Schrack, who was a manufacturer of paints in Philadelphia in 1816, later established the varnish manufacture, and already in 1836 an export trade in American-made varnishes had begun.

The manufacture of shot by the granulation of lead, while not properly called a chemical industry, is closely related to the lead pigment manufacture. This manufacture of lead shot was one of Philadelphia's earliest industries. From Winslow's "Biographies of Successful Philadelphia Merchants," page 142, we quote:

"On the Fourth of July, 1808, the corner-stone of the Southwark shot tower, in John Street, between Front and Second, was laid by the firm of Cousland, Bishop and Sparks, and the building was pressed forward rapidly to completion. Thomas Sparks paid particular attention to this branch of the business, and in a short time the patent shot of the firm became celebrated thruout the country. So long as this article was used by sportsmen and hunters, there seemed to be no difficulty about the propriety of the manufacture in the firm. But when the war of 1812 broke out, the firm then being Bishop and Sparks, the senior partner, who was a consistent member of the Society of Friends, felt conscientious scruples as to the rightfulness of continuing a manufacture which the United States now demanded should be turned to the production of munitions of war. John Bishop, therefore, withdrew from the firm, and retired from business.

"Thomas Sparks, therefore, continued the business for several years alone. In 1818 he took into partnership his brother, Richard Sparks, and the firm continued at No. 49 South Wharves, as Thomas and Richard Sparks, the shot tower operations being in full play. It was necessary that

they should reside near the tower, and accordingly Thomas had his house at No. 476 South Front Street and Richard at No. 478. This partnership did not last very long. Richard Sparks fell a victim to the yellow fever in the year 1821, and for many years Thomas Sparks continued at No. 49 South Wharves, and at the shot tower, without a partner. In the year 1838 he took in with him his nephew, Thomas Sparks, Jr., a son of Richard. The business was then conducted under the firm name of Thomas & Thomas Sparks, Jr., at the old stand, which from No. 49 South Wharves had become No. 49 South Delaware Avenue."

One of the lines of manufacture that contributed to make Philadelphia a great chemical centre early in the last century was that of the yellow and red prussiates of potash. I have been furnished a private memorandum concerning the activities of the firm who began this industry and were active in it for many years.

"Under the firm name of Carter & Scattergood a profitable chemical manufacturing business was conducted from 1834 to 1911; and was absorbed in the latter year by The Henry Bower Chemical Mfg. Co.

"John Carter and Joseph Scattergood bought out the old established business of 'John & Daniel Elliott' founded in 1754 by their grandfather, John Elliott.

"The Elliotts' place of business and factory was originally on Front Street between Chestnut and Walnut Streets, but in 1812 the manufacturing work was transferred to a new factory which they erected at 19th and Pine Streets, John Carter becoming their apprentice January 1, 1816.

"The list of chemicals produced by Carter & Scattergood was an extensive one, John Carter being the manufacturer and Joseph Scattergood the business man of the concern. It included citric, tartaric, oxalic, nitric and sulphuric acids, bichromate and prussiates of potash and many other articles, but their operations during the first ten years of their business were on a scale which in this day would be considered quite small.

"Yellow prussiate of potash was first made by them in 1834 (that being so far as known the first production of the article in America), but the demand was very small, only 472 pounds being absorbed by the market in that year. In 1835 the sales increased to 6443 pounds, but it was not until 1843 that the demand became large, the sales amounting in that year to 69,470 pounds and rapidly increasing in the next two years, the sales in 1845 being 207,522 pounds.

"The high price, over 50 cents per pound, and the keen demand, of course, resulted in active competition, and the market for many years was oversupplied.

"In the year 1846 Carter and Scattergood began to produce red prussiate of potash, being the first in America. This was a highly profitable branch of the business until the introduction of coal-tar dyes, as substitutes for prussiate colors on woolen goods, gradually displaced it in the most important field of consumption. Except for the manufacture of Blue-Print Paper, there is now very little demand for it."

Potash and ammonia alums were first made in Philadelphia by Charles Lennig in 1837 and by Harrison Brothers in 1840.

Coming now to the early manufacture of medicinal or pharmaceutical chemicals which has long made Philadelphia famous, we find that George D. Rosengarten and Charles Zeitler as Rosengarten & Zeitler began the manufacture of chemicals in St. John Street, Philadelphia, about 1822. They were the first to manufacture the alkaloids of cinchona and opium in this country, having

begun the manufacture of sulphate of quinine in 1823, of sulphate of morphia in 1832, and strychnine in 1834. The salts of quinine were also manufactured by John Farr in 1825.

These two firms and their successors have had much to do with the establishment of Philadelphia as a chemical manufacturing centre. After the withdrawal of Mr. Zeitler, which took place within a year, Mr. Rosengarten continued alone, later taking in a Mr. Dennis. When this partner withdrew some twenty years later, the firm became Rosengarten & Sons, which business continued until the formation of the present combination with the other large Philadelphia manufacturer of medicinal chemicals, Powers & Weightman.

"Farr & Kunzi began the manufacture of chemicals about 1818. Abraham Kunzi, a Swiss by birth, retired in 1838, and the senior partner, John Farr, who had been born and brought up in England, associated with himself Thomas H. Powers and William Weightman, two young Philadelphians, who had been in the employ of the firm for some time. The new firm name was John Farr & Co. This was later changed to Farr, Powers & Weightman, and, on the death of the senior partner in 1841, the firm name was again changed; this time to the title—Powers & Weightman, by which it was so long known thruout the entire country."

These two firms in 1905 united under the name of the Powers-Weightman-Rosengarten Company and continued as probably the best known manufacturers of general and medicinal chemicals in the United States.

The history of the commercial production of pure glycerine is also of interest in this account of Philadelphia's chemical achievements.

The late Robert Shoemaker while making medicinal plasters had his attention directed by Professor William Procter to the residuum liquid which was obtained. From this he prepared the first glycerine made in this city, if not in America, in 1846, and this was exhibited by Professor Procter to his class at the Philadelphia College of Pharmacy at the time. Mr. Shoemaker manufactured it for sale according to his statement for some years in connection with the manufacture of lead plaster.

The later development of the refining of waste lyes containing glycerine was also a Philadelphia achievement and was worked out by the late Henry Bower. By the courtesy of his son, Mr. W. H. Bower, I am allowed to quote from a private letter which gives the account of his work, in his own words:

"Quite early in life, say in 1857, my attention was keenly directed to some mode of purifying these waste liquors of the stearine candle factories, and in that year I could have purchased the entire product of crude glycerine of the United States for a sum not exceeding \$5000, altho the manufacture of it was nearly if not quite as large then as now.

"I commenced work in earnest to experiment in purifying glycerine in 1858—and expended long and weary efforts, all my earnings, as well as some borrowed money. I at first succeeded in producing an article sufficiently pure for use in gas meters (in place of alcohol) to prevent freezing and stoppage of the instrument—it was not, however, until about the middle of 1860 that I succeeded in making and placing in the

market a 'pure inodorous glycerine'; even then the amount sold was quite insignificant. Inferior grades made their appearance about the same time in the West. The bland and neutral nature of the article, and the discovery of various uses for it, soon increased the demand to a marked extent; I was enabled from time to time to increase my works, and in increasing them was making steady inroad into the supply of the crude article. At this period, say in 1863, the business of refining glycerine was scarcely known on the continent of Europe, and I exported small quantities to Hamburg paying a profit; Belgium, France, Germany and Austria were immense producers of crude glycerine, but, like its sister product here in previous years, it only found its way to the sea. As before stated, the use and sale of the refined continued to improve, the crude growing more scarce each season, until a point has been reached when every available pound is worked into a valuable product. It would not be out of the way to place the total value of all the glycerine sold in the United States at this time at \$500,000. This sum could never have been reached had it not been for the discovery of a mode for refining, to which, so far as this country is concerned, I lay claim; by a careful management of my business for some years I kept the process a secret; but in time some portions of it came to the knowledge of other persons, who have been enabled to produce very fair articles. There are besides myself, here, two refiners in Cincinnati, one in Chicago, and one in New York."

There were of course other drug and chemical firms who were well and favorably known in the early half as well as the later half of the nineteenth century.

We have already mentioned the name of Christopher Marshall, Jr., who was active in Revolutionary days. Himself the son of a druggist, he was succeeded by his son, Charles Marshall, and his grandson, Charles Marshall Jr., who in 1814 established himself in the wholesale business at 310 Market Street.

With this Charles Marshall, Jr., entered as an apprentice George W. Carpenter, who later became one of the most prominent as well as successful of wholesale druggists in Philadelphia. The old store of Carpenter & Henszey at Eighth and Market Streets I remember quite as well as it stood about 40 years ago.

A very well-known drug firm of the latter half of the nineteenth century was that of Bullock & Crenshaw. They were the successors to Smith & Hodgson, who established themselves as druggists at the corner of Sixth and Arch Streets in 1819, where they continued until 1849, when they disposed of their drug business to two of their employees, who then formed the firm of Bullock & Crenshaw. This firm carried on not only a wholesale drug business but handled fine chemicals and chemical apparatus, supplying many colleges and schools thruout the country. In September, 1868, they moved to 528 Arch Street, where in larger quarters they carried on a flourishing business until the death of Mr. Charles Bullock, the surviving partner.

The firm of French, Richards & Co. was for many years one of the best known of Philadelphia drug firms at its centrally located store, Tenth and Market Streets. The founder of this firm was Clayton French, who in 1840 entered the drug business as an apprentice

(Continued on Page 432)

THE POSITION OF THE ENGINEER IN THE COMMUNITY AND HIS RELATIONS TO THE CONTRACTOR

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THE engineer is primarily a man whose life is devoted to promoting and planning things that actually happen, and without doubt he is slowly but surely assuming his rightful position in the world, because it is becoming universally recognized that he, above all of his fellows, is better fitted by his education, experience, and, generally, his temperament to fill those positions in the direction of the world's material progress which require, among other things, sound, sane and intelligent judgment and at the same time administrative ability, energy, technical and scientific knowledge of a high and varied order.

Of course, initiative, candor, truthfulness and efficiency, and, above all, integrity, are presupposed and let us hope can usually be taken for granted.

Engineering is an art and a science. It is a science in so far as certain physical laws are its basis. It is an art in so far as in the application of these laws the best judgment inherent in or acquired by man must be exercised. It is the engineer who is the pathfinder and pace-maker in modern civilization, and it is he who more nearly than any other individual can be likened unto Jove of old, whose command of the elements used to be universally acknowledged and is proverbial, and it is the engineer who, to-day, is largely charged with encroaching on His ancient and honorable preserve.

Little progress would be made in the modern world if the engineer did not blaze the way, and a giant's share of the progress in material things which has been made since the birth of the First Napoleon has been made by engineers, and incidentally it may be observed that, since his birth, there has been more actual progress than was made during two thousand years that preceded it. That there is far more difference between our world and that in which Bonaparte was the central figure than there was between his world and that of Julius Cæsar, most of which difference has mainly been brought about by the engineer, cannot be disputed. Much yet remains to be accomplished. Unknown and exhaustive domains no doubt are still to be explored and exploited, but, stupendous as is the task, the engineer will, when the day of reckoning arrives, be found to be in the forefront.

To cope with those impediments which Nature and man set up in the way of material progress, and to transmute or convert these into processes for the use and convenience of mankind, is the acknowledged function of the engineer, and he has not heretofore been, nor shall he in the future be, found wanting.

To be more specific, in the ultimate analysis the elemental components, physical, mental and moral, which

in the ensemble constitute the engineer, as herein stated, may be said to be character and experience, imagination, efficiency, executive and technical ability and scientific knowledge. While no one of these principles can be said to dominate the rest, still in a general sense there is no disputing the fact that character stands first. It is the framework or foundation on which the other characteristics are built.

Technical ability and scientific knowledge are not written first because it is thought to be of little importance, but because ultimately the other principles being broader have a bigger bearing on the resultant man.

A man may be a great engineer with only sufficient scientific knowledge to eliminate the impossible and whose sole characteristics are his imagination, ingenuity, and experience, but who possesses a mind capable of conceiving or forecasting and in rare instances defining the desirable and necessary (as the case may be) in the human economy. Such was the elder De Lesseps, James J. Hill, Harriman, Carnegie and a host of others among the pioneers in industry on this continent.

Imagination is to be interpreted as broad vision, creative ability.

Technical ability considers scientific knowledge applied in the light of experience, reason and common sense.

Efficiency is generally defined as the ratio of the work expended to that produced and in a larger sense is the process of effectively correlating all of the operating forces and energies in one unit for economical production.

Executive ability is the process of successfully commandeering and utilizing the services of others.

The provinces of engineering and economy are often intertwined to such an extent that it cannot be said distinctly just where one ends or the other begins. Engineering which is not economical is not good engineering, and economy which will not bear rigid scientific investigation or treatment, such as an engineer would subject it to, is not economy.

Where we attempt a rigid mathematical analysis in any instance, we must be sure of the premises, and it should be remembered that scientific analysis does not necessarily mean mathematical precision to the exclusion of the broader judgment based on experience and common sense.

An engineer's education after it reaches a certain stage should be along broad lines, to include the humanities, so as to fit him for leadership.

A knowledge of men which the old school believes can only be had by contact, but which some now seem to think can be obtained thru the mastery of what has

been called the Science of Character Analysis of Dr. Blackford, is more to be desired than a knowledge of integral calculus and by all odds gives one a better chance in life.

Many engineers are of necessity employed by industrial and commercial organizations. Some are born to lead and others to serve—in whichever class we find ourselves it is up to us to do our utmost. To be able to intelligently and successfully carry out orders is a faculty not to be despised and, by the way, it is not the easiest task imaginable.

Man, to distinguish him from nature's other animate creatures, possesses a mind to think, a will to act and a keen discriminating power; is generally designated anthropoid or upright walking, upstanding and his center of gravity is so located that he leans slightly, it may be said almost imperceptibly forward. In order for him to be honest in the strictest sense, to be what is colloquially called straight, it isn't necessary for him to change his poise to the extent of shifting his center of gravity as to lean backward. Man also is built on the lines designated by the biologist as "bilaterally symmetrical," in other words not one-sided, and his discriminating powers should enable him and his knowledge of mathematics should direct him to be able to differentiate between the rights of the side which employs him and the other side so that each should receive his due, and it is not at all necessary that he get 51 per cent. in any bargain in order to be sure that the other fellow is not getting the better of him.

An engineer's actions should be guided solely by the Golden Rule, and equity, not policy; that is, strict justice, rather than law, should govern. In his relations with the contractor he occupies a sort of judicial position, and must possess great discriminating powers and must appreciate point of view. This is well exemplified in *Æsop's Fable of the Forester and the Lion*.

Walking in the woods one day, they fell to discussing the question, "Which is the stronger, a Lion or a Man?" Unable to arrive at a mutually satisfying answer, they were about to dismiss the subject when quite unexpectedly they came upon a piece of statuary representing a man in the act of throwing down a lion. "There," said the Woodsman, "you see the man is the stronger," to which the lion replied, "Ah, yes; but their positions would have been reversed if a lion had been the sculptor."

It is better to be right and to act justly, even if appearances are against you, than to be guilty of a wrong, even with appearances in your favor.

In his relation to his employers it goes without saying that they are the sole judges as to his ability and fitness. In his dealings with them he must possess candor and ability to look out for their interests without sacrificing his own. It is a fact that is not to be disputed that he must be true to himself, first, and that he must not forget or overlook his own interests, or, as the immortal Shakespeare puts it in Polonius's advice to his son:

To thine own self be true,
And it must follow, as the night the day,
Thou canst not then be false to any man.
Hamlet.

To become so absorbed in your work as to be oblivious to one's own interests is not demanded by any of the precepts or the examples that we have of the greatest of our professional brethren, and it can rightfully be said that disloyalty is a crime, whether to one's self or to one's employers or clients.

In every instance the contractor should receive a square deal at the hands of the engineer and in no instance should the engineer have it in his mind to get square with the contractor for some fancied or even real act of omission or commission. Those who have had sufficiently broad experience recognize that specifications are intended to be interpreted in the spirit, rather than in the letter. As Theodore Cooper, in his day recognized as the foremost bridge engineer in this country, put it, "The best system of rules to insure success must be interpreted on the broad grounds of professional intelligence and common sense."

Constant bickering, indicating lack of poise and persistent petty fault-finding without being able to offer suggestions for the betterment of conditions, is the method pursued by many young engineers to the detriment of the work on which they are engaged, and reminds one of the fault-finding mother's instructions to her daughter: "Mary, go out into the back yard and find out what Johnny is doing and tell him to stop."

There is absolutely no reason why the most cordial relations should not exist between the contractors and engineers engaged on the same work and there are probably the very best of reasons why they should, as their interests are alike.

The specifications are often the rock on which the cordial relations of the engineer and the contractor are rent asunder.

Contractors, like engineers, are actuated by the same motives as other men. The engineer may or may not be superior to the contractor, but he cannot show his superiority by taking undue advantage of him. Let not the contractor have occasion to look on the engineer in the characteristic manner described by Bret Harte:

That for ways that are dark
And for tricks that are vain
The heathen Chinese is peculiar.

Contracting, according to the usual methods in vogue, of which some one has aptly said, "The profits are limited by competition, but the losses may be unlimited," should no longer prevail, but as it is or should be a legitimate business, the gambling element should be removed therefrom, and should certainly not exist to a greater extent than it exists in any other ordinary business.

Contractors would be better men as well as better contractors if their remunerations were fixed, rather than problematical as is usual.

The party for whom the work is being done should

take all of the incumbent risks, and then any incentive of the contractor to take advantage is removed.

Some specifications deliberately give the engineer the whiphand, but it has been determined in the courts of this country that it cannot be employed without considerable danger. As engineers we know that the action and reaction are equal.

Clauses which have a double meaning or which can be interpreted in two ways should not be written in specifications. A contract represents a meeting of the minds of the contracting parties. The engineer should not attempt to protect himself by inserting obscure clauses in specifications whereby he may cover up his own ignorance or shortcomings at the expense of the contractor.

Copying clauses from one specification into another without fully understanding their meaning, simply because they are time honored, *i.e.*, because custom has sanctioned them, which is not unusual, is a very silly and at the same time dangerous practice, and reminds one of Mark Twain's experience in writing a German letter which is cited in one of his books, where he subscribes himself—"Ich habe die Ehre zu Sein Ihr ergebenster u. s. w." (a free translation of which is—"I have the honor to be your servant, etc."), and he states that he doesn't know exactly what it means, but it is always written at the end of a German letter.

Few men have ever been vested with considerable power who haven't at times abused it, and the engineer who prepares the specifications and who interprets them

and who in the case of dispute has the last say, in fact is the "sole arbiter," has to be a bigger man than the ordinary to be absolutely unbiased. In the case in question the engineer is judge, jury and prosecuting attorney, all welded into one, and the one who usually suffers, and to whom is meted out the punishment, unless the engineer happens to be a very big man, is the contractor.

In closing I will quote a few lines from a little poem by J. G. Holland, called "True Men," which in my judgment describes the type of men from which the engineering profession should be recruited:

Men who the lust of office cannot kill;
Men who the spoils of office cannot buy;
Men who possess opinion and will;
Men who love honor; men who will not lie.
Men who stand before a demagogue,
And brave his treacherous flattering without
winking;
Tall men, sunburnt, who live above the fog,
In public duty and in private thinking.

And if I may be allowed further to quote from the address delivered by the writer on the occasion of his induction into office as President of the Engineers' Club of Philadelphia, "The men of our profession should be of those who think quickly and accurately, who feel strongly and generously, men of sound judgment and catholic temper, men with a fine sense of personal and professional rectitude, men who as Ex-Governor Hughes, since Associate Justice U. S. Supreme Court, said "are to be the trustees of the future of a great country."

NEED OF TECHNICAL MEN

THERE is an imminent matter of vital importance to the American nation concerning which very little, if anything, has been said in the newspapers—hence the presentation of this letter, and with it an urgent request for its publication in your columns. I refer to the depletion of the classes in technical schools, first, by widespread volunteering for the Army and Navy, and, second, by conscription. This subject received much attention at the Washington meeting, on the 6th and 7th inst., of the Society for the Promotion of Engineering Education, an organization of twenty-five years' standing and composed of most of the leading American instructors in all lines of applied science, and also a few prominent practising engineers. The meeting was addressed by such distinguished men as the Secretary of War, the Chief of Engineers of the United States Army, and the Director of the Bureau of Standards. The five sessions held by the Society on those two days were devoted almost exclusively to questions of public welfare, principally connected with the war, its subsequent conditions, and its anticipated problems. As I attended all of the sessions from start to finish and took the deepest interest in the entire proceedings, I feel justified in making the following statements, and in claiming that they express the opinions of a number of the most profound thinkers of America:

First.—The larger part of the civilized world will have to be reconstructed after the war, not excluding our own great railroad system, which undoubtedly will have deteriorated on account of over-use and lack of adequate upkeep.

Second.—Such reconstruction is almost exclusively the work of engineers.

Third.—The European technical men have been killed off by thousands during the past three years; and their slaughters will not cease until the war ends. Moreover, it is more than probable that many American engineers who serve in Europe will never return to our shores, and that a large number of those who do come back will be more or less incapacitated from active professional work.

Fourth.—The technical schools of all the other warring countries than ours have practically been out of commission for three years, thus cutting down there, almost to zero, the supply of new men for the engineering profession.

Fifth.—The call to arms in this country by both volunteering and conscription it is feared will soon have reduced to about one-half the attendance at the technical schools of the United States, while instead of being halved it ought properly to be doubled.

Sixth.—In spite of the present paralyzation of many

(Concluded on Page 432)

CODE OF LIGHTING*

FACTORIES, MILLS AND OTHER WORK PLACES

SECTION X. SYSTEMATIC PROCEDURE SHOULD BE FOLLOWED IN CHANGING A POOR LIGHTING SYSTEM OVER TO AN IMPROVED ARRANGEMENT.—When undertaking the change from an old to a new lighting system, the various forms of illumination which are adapted to factory and mill spaces should be studied, and an investigation made of the various types of gas and electric lamps on the market which are available for the purpose.

Time should be allowed for a study of the given locations to be lighted; for preparing the plans of procedure in the installation of the gas or electric lamps and auxiliaries; and for customary delays in the receipt of the necessary supplies and accessories

fitters is likely to be heaviest in the winter, due to the dark days. Where this condition exists, there is all the more reason to apportion out new work so as to accomplish it during the months of least wiring and piping repair activity, and, further, at that time of the year when employees will be comparatively unaffected by the disturbances usually associated with a change from an old to a new lighting system thru possible irregularities in the illumination service while the wiremen or fitters are at work.

Distribution of Expense.—Another feature different from the foregoing viewpoint is in the distribution of the installation cost over a relatively long interval.

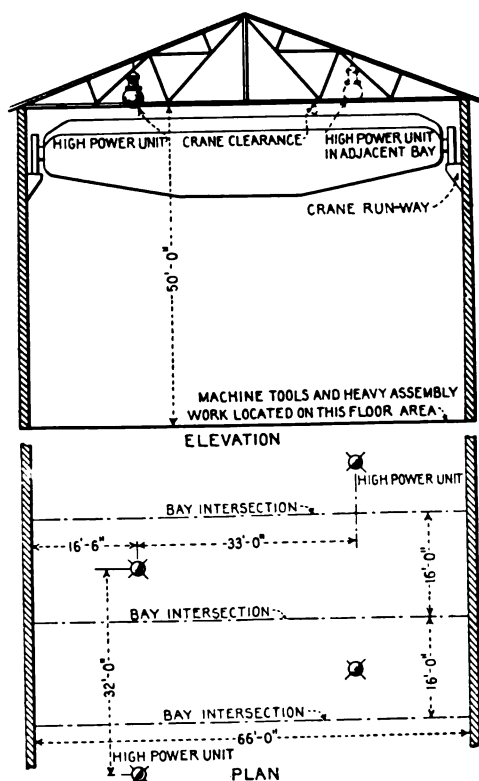


FIG. 18.—DIAGRAM SHOWING THE USE OF LARGE LAMPS FOR A MOUNTING HEIGHT OF 50 FEET.

to the work in hand. Altogether, therefore, work of this kind requires considerable time for its completion.

Using the Shop Force.—In large factories or mills, a wiring or gas-fitting force is sometimes a part of the maintenance division. The work of the wiremen or

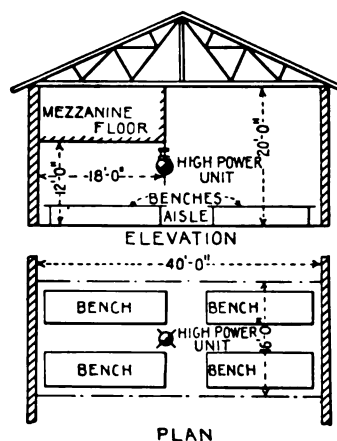


FIG. 19.—THIS SHOWS A VERY POOR ARRANGEMENT OF ARTIFICIAL LIGHTING BY MEANS OF LARGE LAMPS MOUNTED TOO CLOSE TO THE FLOOR. COMPARE THIS POOR LIGHTING SCHEME WITH THE IMPROVED PLAN IN FIG. 20.

If, for example, the system is desired for the approaching winter, the complete wiring or piping plans may be drawn up and blocked out into three, four, or even more sections, thus spreading the expense over as many months.

Yearly Appropriation.—In some shops a given appropriation may be allotted each year for building equipment. From the standpoint of finance plans, it may thus be desirable to distribute outlays of this nature over the year, rather than to concentrate them at any one time. *An important consideration in this method of installing lamps, however, is to prepare in as far as possible the complete plans in advance, at least as regards given factory or mill sections, so as to insure a uniform and symmetrical installation as a whole when the component parts are finished.*

* Continued from Page 376, August issue.

SECTION XI. REFLECTORS AND THEIR EFFECT ON EFFICIENCY.—A reflector or shade is used in conjunction with a lamp for the purpose of reducing the glare otherwise caused by looking directly into the bare lamp, as well as for the purpose of redirecting the light most effectively to the work.

Reflectors and shades are now obtainable so designed as to be specially adapted to give sizes and types of the smaller and medium-sized line of lamps, and hence care should be used to be sure that both reflectors and lamps are of the correct size in their relation to each other. This is of the utmost importance in

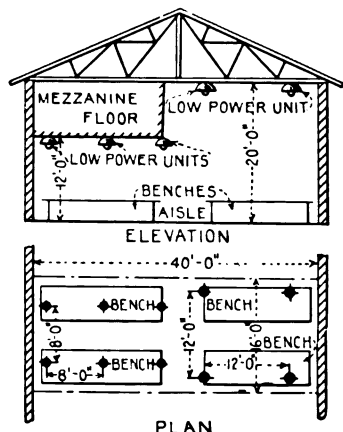


FIG. 20.—THIS ILLUSTRATION IS TO BE COMPARED WITH FIG. 19. IT INDICATES AN IMPROVED SCHEME OVER THAT SHOWN IN FIG. 19, MADE POSSIBLE BY THE USE OF SMALLER LAMPS.

securing uniform illumination for a given spacing distance and mounting height of the lamps. For a certain ratio between the spacing and the height of the lamps a reflector can nearly always be selected which will furnish uniform illumination over the working surface. (These remarks concerning reflectors apply particularly to lamps of the tungsten type and to small gas units.)

Function of Reflector.—Owing to the direction of the light from the lamp, nearly all types of lamps, in addition to the downward light, furnish some rays which go upwards and away in other directions from the objects to be illuminated, and are therefore relatively not useful. Furthermore, a bright source in the field of vision causes an involuntary contraction of the pupil of the eye, which is equivalent to a decrease in illumination in so far as the eye is concerned. Hence, while reflectors or shades may at first seem to reduce the amount of light in the upper part of the room, their use actually increases the amount of light in a downward useful direction, and improves the "seeing," due to the better conditions which surround the eyes. The economic function of the reflector, as contrasted with the easier conditions it affords the eyes, is to intercept the otherwise useless or comparatively useless rays which do not ordinarily reach the work, and to reflect them in a useful direction. In performing this function, there is a choice

thru the design of the reflector, in the manner of distributing the light so as to make the illumination on the floor space uniform with certain spacing distances and mounting heights as previously mentioned.

Avoiding Dark Spots.—With the use of lamps for which a large variety of reflectors is available, the proper reflector should therefore be chosen so as to give the desired distribution of light. In other cases, as in the use of the gas or electric arc lamps, where the globe or reflector is usually a fixed part of the lamp, care must be exercised to space the lamps at sufficiently close intervals to insure uniformity of the illumination; that is, a freedom from the relatively dark spaces which exist between lamps when spaced too far apart.

Light Interiors.—With a light ceiling, the reflection of that part of the light which passes thru a glass reflector to the ceiling, and which is added to the light thrown downward from the under surface of the reflector, is a factor in building up the intensity of the illumination on the working surface. *Great importance is therefore attached to light interior colors, especially on ceilings and the upper portions of walls, both in reinforcing the direct illumination and in giving diffusion, which in turn adds to the amount of light received on the side of a piece of work.* It should also be stated that the intensity of the light from bare overhead lamps when measured on the working surface may be increased by as much as 60 per cent. thru the use of efficient reflectors. This is due to the utilization of the horizontal rays of light, as previously stated, which predominate in the bare lamp, whereas the most effective light in factory and mill work is apt to be that which is directed downward.

Glass and Metal Reflectors Compared.—The question is sometimes raised as to the use of glass reflectors in connection with lamps for factory and mill lighting. This question is largely one of economy and maintenance, and it may be answered either in an offhand way or on a basis of practical experience with both types.

In large installations of small units there has been an effort to establish the merits of glass and of metal reflectors by equipping lamps in adjacent bays with glass reflectors in one case and with metal reflectors in the other. It has been found almost invariably that if the choice is left to the workmen and superintendents, glass reflectors will be given preference over metal, mainly on account of the added cheerfulness they produce. If, therefore, the first cost and maintenance expense of the glass reflectors is practically the same as with metal, then glass may be employed to advantage.

Reflector Efficiency.—Glass reflectors on the market are capable of producing an amount of illumination equal and even greater in some cases than that produced by the best metal reflectors, and even if the first cost is somewhat higher, the added advantage of glass as opposed

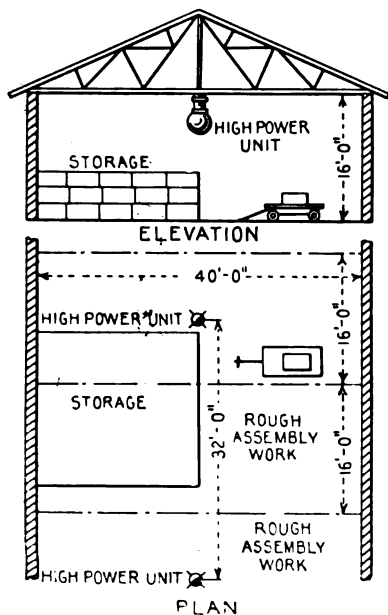


FIG. 21.

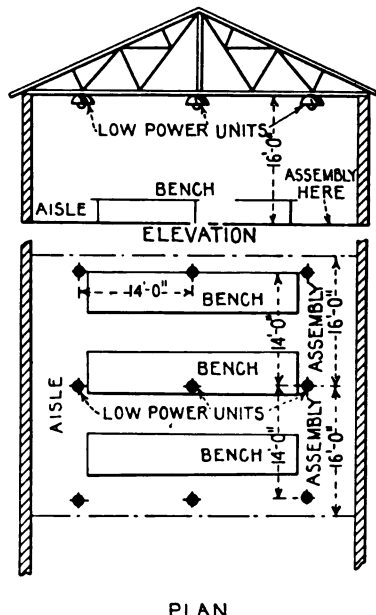


FIG. 22.

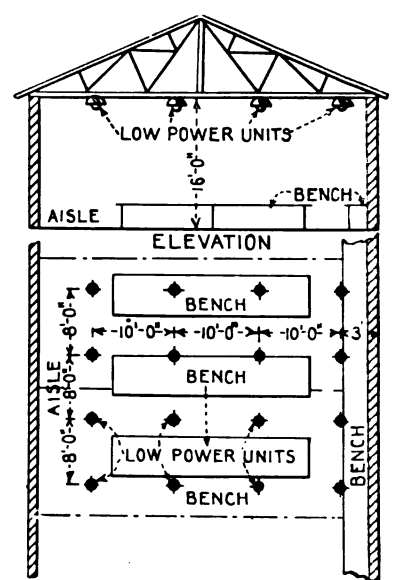


FIG. 23.

THESE THREE ILLUSTRATIONS SHOW VARIOUS WAYS IN WHICH A FACTORY SPACE WITH 16 FEET GIRDER CLEARANCE CAN BE HANDLED, DEPENDING ON THE CLASS OF WORK PERFORMED. THE FIRST CASE, FIG. 21, IS FAIRLY SATISFACTORY, FOR STORAGE SPACES, AND EITHER THE SECOND OR THIRD CASES, FIGS. 22 OR 23, CAN BE EMPLOYED FOR BENCH ASSEMBLY OR MANUFACTURING. THE THIRD CASE, FIG. 23, IS TO BE PREFERRED WHERE THE CLASS OF WORK CONSISTS OF THE HANDLING OF SMALL MACHINERY PARTS.

to metal is usually sufficient to make the small difference in cost a negligible item. This factor is all the more noticeable when one considers that the reflector itself is a small part of the total cost connected with the wiring or piping of the lamp and its reflector.

Pierced metal reflectors are also available. These are designed with small openings at the upper portion of the metal so that the reflector may give the same distribution characteristics as a given glass reflector, thus affording a suitable metal reflector for use where glass may be objectionable. Some of the advantages of the pierced metal reflector are that it is unbreakable and that accumulations of dust on the outer surface do not decrease the efficiency. It is also true that the light which passes thru the openings in this reflector to the ceiling cannot be diminished by dust on the outer surface as in the case of glass reflectors. (This type of reflector is shown in Fig. 8 under the main line shafting.)

Reflector Maintenance.—Regarding the maintenance of glass reflectors under rough factory and mill conditions, it may be stated that glass reflectors are used quite widely with almost a negligible increase due to breakage. Thus, out of the total maintenance cost in one representative installation, it was found that the charges were proportioned as follows:

Renewals, cost of lamps (tungsten)	75 per cent.
Renewals, broken glass reflectors	3 per cent.
Labor, making renewals and changing reflectors	
for washing	16 per cent.
Labor, reflector washing	2 per cent.
Additional indirect charges	4 per cent.
Total	100 per cent.

Points to Consider.—Reflectors will not be classified here from the commercial standpoint, but the following items should be given consideration in the selection of the type of reflector for factory or mill use:

1. Utilization efficiency: how much does the reflector contribute to the effective illumination on the work?
2. The effect in reducing glare.
3. Natural deterioration with age thru accumulations of dust and dirt.
4. Ease in handling and uniformity of manufacture.
5. Physical strength and the absence of projections which may increase the breakage in case of glass reflectors.

A study of the various reflectors on the market with the aid of these items as a basis will determine what reflectors are best adapted to given conditions. Regarding the third item in the foregoing list, it may be stated that under comparative tests in service, the accumulations of dust and dirt on glass reflectors do not seem to be any greater than the coating of dirt which accumulates on the inside of a metal reflector in the same length of time.

SECTION XII. SIDE LIGHT IMPORTANT IN SOME FACTORY AND MILL OPERATIONS.—It has been customary in many cases to measure the effectiveness of illumination terms of the vertically downward component of the light. This method has ignored the value of side components in relation to vertical surfaces and openings in the side of the work. It is sometimes more necessary to light the side of the machine or the side of a piece of work than the horizontal surface. If, then, in designing a factory or mill lighting system, the prime object is the production of the greatest amount of downward illumina-

nation, it may happen that the side component is so small that the sides of machinery or of work are inadequately lighted.

Two Ways to Secure Side Light.—Experience indicates that there are two general ways in which to secure adequate side lighting. One of these methods is to lower the lamps, and the other is to use broader distributing reflectors than are called for by the rules which consider uniformity of the downward illumination only. Side walls or other reflecting surfaces will modify the results. Thus, after the determination of a certain type of reflector for producing uniform vertically downward illumination, it may be found that more side light is necessary, and this extra side component may, as stated, usually be secured by selecting a somewhat more distributing reflector. Broader distributing reflectors are apt to result in less downward illumination and will sometimes call for larger lamps than found necessary by preliminary calculations.

Practical Case.—As an illustration, in a certain lighting system a vertically downward intensity of about 3 foot-candles was deemed sufficient for the work involved. Measurements and observations showed that the side light was insufficient. In this particular installation it was found necessary to produce a vertically downward intensity of about 5 foot-candles on the average in order to secure an intensity of about 2 foot-candles on the side of the work, and also to use a somewhat broader distributing reflector than at first chosen. Two foot-candles on the sides of the work were sufficient in this case where bench work and work in the vise on small machine parts were conducted.

Keeping the Lamps High.—It is recommended that the lamps be mounted near the ceiling in all reasonable cases where side light is necessary, and that the side light be increased, *not by lowering the lamps*, but thru the medium of broader distributing reflectors and larger lamps, if required. This attitude is taken on account of the glare which results when lamps are mounted too close to the work, a feature most noticeable in the absence of a reflector or where glass reflectors are used.

SECTION XIII. MAINTENANCE.—The importance of system in the upkeep of natural and artificial lighting equipment may not appeal to every reader at the outset, but a consideration of the points involved will indicate that neglect of such work is apt to result in excessive losses of otherwise useful light.

Windows.—Factory and mill windows become covered in time with dirt, and produce greatly decreased values of natural light in consequence. These losses may easily be great enough to affect the workmen seriously, and to necessitate the use of artificial light at times when otherwise it would not be required. Dark surroundings also increase the likelihood of accidents. Regular window cleaning should therefore be a part of the routine of every factory and mill building or group of buildings.

Lamps.—Carbon filament, mercury-vapor, gas mantle and tungsten lamps burn out or break, globes and reflectors become soiled, and the various other items of deterioration take place so gradually that in many cases they are given no special concern in the practical economy of the shop. Moreover, it is hardly necessary to mention the fact that often lighting systems are allowed to deteriorate to an extreme point and nothing is done unless complaints come in from employees after the lighting facilities here and there thruout the shop have become so poor that work has to be discontinued temporarily. The losses of time from such circumstances, when added up thruout a year, are more than likely to exceed the expense of systematic attention to such maintenance items in advance.

Overhead System.—Furthermore, with modern methods, where the lamps are usually mounted overhead rather than close to each machine, the importance of relieving the workmen from any care of the lamps and placing it in the hands of a maintenance department is even greater than has been the case in the past, particularly in large plants. To indicate the wisdom of a daily renewal of electric lamps, Fig. 24 has been worked up from the experiences in one large factory. In this factory all burned-out lamps are renewed each day except Saturday and Sunday, these renewals being based on a daily inspection of every lamp to ascertain whether or not it is in working condition.

Lamp Renewals.—A reference to the diagram shows that the renewals are considerably greater on Monday than on any other day of the week, this increase being due to renewals not given attention on the two preceding days. Obviously, therefore, a continued neglect of the inspection and renewal of these lamps would soon result not only in inferior lighting conditions, but to large losses of time for the employees, not to speak of the annoyance involved.

Reflector Cleaning.—The serious loss of light when globes and reflectors are allowed to go for long periods without cleaning is shown in Fig. 25. This set of curves resulted from a test on a glass reflector used with a tungsten lamp. The one curve shows the value of the light given by the lamp at different angles when the lamp and reflector are clean, while the smaller curve shows the enormous reduction of light after the lamp and reflector have been in service for about four months without being cleaned.

In this particular case, which is a typical one, the loss of light at the end of the four-month interval amounted to about 50 per cent. The cost of electrical energy in this shop was such that the loss of light during the four months amounted to about 12 cents, while the total cost of taking down, washing, and replacing this reflector amounted to about 3 cents. The economy of a fairly frequent attention to cleaning of such reflectors is at once apparent, even if the improved condition of the light in itself be ignored.

The examples just given, in the one case associ-



FIG. 26.—VERY POOR LIGHTING IN A WORSTED GOODS FACTORY. THE WIRING IS BADLY ARRANGED, THE CONTRASTS BETWEEN LIGHT AND DARK PORTIONS OF THE ROOM ARE EXCESSIVE, AND IN SOME CASES THE WRONG SIZE OF LAMP IS USED IN A GIVEN REFLECTOR. THE SYSTEM IS UNSIGHTLY AND REPRESENTS BAD PRACTICE. COMPARE WITH FIG. 27.



FIG. 27.—WORSTED MILL WITH LOCALIZED GENERAL ILLUMINATION. THIS IS AN EXAMPLE OF EXCELLENT ILLUMINATION WITH TUNGSTEN LAMPS AND METAL REFLECTORS. NOTE THE REFLECTION FROM THE GOODS TO THE CEILING. COMPARE WITH FIG. 26.



FIG. 28.—VERY POOR ARRANGEMENT OF ARC LAMPS. THE LAMPS ARE MOUNTED TO ONE SIDE OF AISLE OVER LINE SHAFTING. VERY LITTLE LIGHT REACHES THE MACHINERY TO THE RIGHT. COMPARE WITH FIG. 29.



FIG. 29.—WELL-PLANNED SYSTEM OF ARC LIGHTING. THE LAMPS ARE HIGH AND ABOVE THE ORDINARY LINE OF VISION. COMPARE WITH FIG. 28.

ated with the renewals of the lamps, in the other with the washing of the reflectors, will serve to illustrate the class of upkeep problems which are involved in shop lighting. The most forcible emphasis is applicable to the idea that system may properly be called a first step towards success in this line of maintenance work.

A Method of Inspection and Maintenance.—In one large factory a regularly developed method of inspection and renewals is employed. As an example, the method as applied to several thousand tungsten lamps, which are

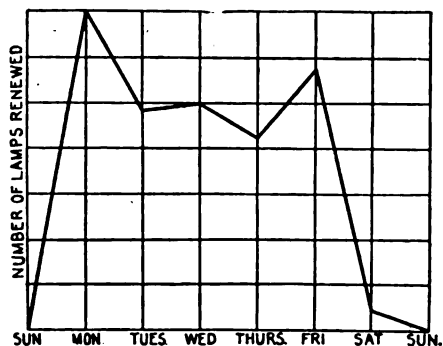


FIG. 24.—FLUCTUATIONS IN DAILY LAMP RENEWALS.

in service in the various buildings, will be described. All the lamps are inspected once per day, except Saturday and Sunday. A regular route is followed by the inspector, and all burned-out lamps, broken switches, loose fuses, and similar items are noted. Careful observation is also made of reflectors which appear to need washing and any other points which might affect the efficiency of the system, after which a report is made

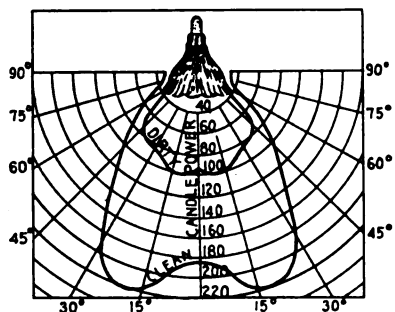


FIG. 25.—CURVES SHOWING SERIOUS LOSSES OF LIGHT FROM A TUNGSTEN LAMP AND ITS REFLECTOR DUE TO ACCUMULATIONS OF DIRT. THIS IS A CONDITION APPLICABLE TO ALL TYPES OF LAMPS, AS OTHER ILLUMINANTS SUFFER CORRESPONDING LOSSES FROM DIRT ACCUMULATIONS.

up about noon and promptly sent to the maintenance department to permit all renewals and repairs to be made before night. In this manner the lamps are well maintained from day to day.

Marking Columns.—To facilitate this renewal work, it has been found advantageous to mark all columns thru this shop. The inspector is thus enabled to indicate clearly the location of each burned-out lamp and the renewal man to locate it without delay. It is helpful

now and then in like manner to have the inspector note the unnecessary lamps found burning when artificial light is not required. If lamps are found burning at such times, a note sent to the head of the department calling attention to the matter is usually sufficient to remedy the difficulty.

Noting Soiled Reflectors.—As a check on a regular cleaning schedule, the inspector should note all reflectors in need of cleaning. The frequency of each cleaning will depend on the rate of deterioration due to the settlement of dirt on the surface of the glass or metal and also on the surface of the lamps, and the fact should be kept in mind that the amount of dirt on a reflector is nearly always deceptive; that is, reflectors which have suffered a large deterioration in efficiency due to dirt often appear fairly clean, and for this reason it is best to increase the frequency of cleaning somewhat over that which seems sufficient from observation, particularly in view of the fact that tests indicate large reductions of light from apparently small accumulations of dust and dirt.

A Method of Washing.—In the factory just referred to, all reflectors are removed to a central washing point. Where the number of reflectors to be hauled is large, a truck is used. Often, however, where only a small number of reflectors is to be transported, small hand racks, devised for the purpose, are employed. When an installation is in need of washing, the scheme is to haul sufficient clean reflectors to the location in question. The soiled reflectors are then taken down and clean ones immediately put into place, after which the soiled reflectors are removed to the central washing point, washed, and put into stock for the next location.

SECTION XIV. EXPERT ASSISTANCE SUGGESTED.—The advantages of securing expert assistance in dealing with illumination are strongly emphasized. The points which come up for solution are complex and require, in many cases, the judgment of one who has had wide experience in the lighting field. In particular, anyone who undertakes to adopt any part or all of these suggestions will do well to secure the coöperation of a lighting expert capable of interpreting the legislative articles and of advising in a constructive manner.

SECTION XV. OTHER FEATURES OF EYE PROTECTION.—Care is urged on the part of those responsible for the health and welfare of employees to see that adequate eye protection is afforded in all operations which are apt to cause injury to eyesight, if such protection is neglected. As typical of such other causes of danger to eyesight, arc welding may be mentioned, where the operator, according to accepted practice, must wear a helmet serving as an eye shield as well as a shield for the face and head in general. *Protective glasses for this purpose should not be judged as to their protective properties by mere visual inspection. They should, however, be*

(Concluded on Page 437)

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EDITORIAL

THE position of the chemist in the life and activity of the nation has changed greatly in recent years, although it required the widespread discussion of military needs and of war preparedness in general to bring the fact to general attention.

The chemist is no longer simply a plodding analyst whose work is of secondary importance to the manufacturer following traditional shop methods and getting results "good enough" without the need of chemical control. That view of the value of chemistry was the cause of both English and American dependence upon the more enterprising German who had earlier learned the value of exact chemical knowledge. It has required the violent breaking up of commercial relations, due to the great war, to teach the lesson both in this country and in England, but the lesson has been pretty effectually learned in the last three years. The American user of dye-colors has learned it, the American fertilizer manufacturer has learned it, and the American textile trade, the paint trade, and many of the metal specialty trades have all learned it. These manufacturers and tradesmen have found that if their problems are given to American chemists for solution they become independent of the foreigner.

American chemists, electrochemists, and chemical engineers have all endeavored to accomplish this revolution in the country's industries, and not only the chemical industries, but also all manufacturing lines based upon the utilization of materials by chemical treatment, have grown with wonderful rapidity and have achieved results not only equal to, but better than, those obtained by foreign help.

It may be of interest to record that the American Chemical Society has a present membership of ninety-eight hundred, and is at present by far the largest scientific organization in the world. It publishes three most valuable periodicals, recognized as such the world over—the *Journal of the American Chemical Society*, the *Journal of Industrial and Engineering Chemistry*, and the *Abstract Journal*, the latter giving in condensed form an epitome of all valuable material published in scientific journals here and abroad. Of equal vitality and cultivating a special field is the "American Electrochemical Society," a vigorous body of some two thousand members holding semi-annual meetings of great interest because of the papers and discussions, and whose *Proceedings* circulates in increasing numbers not only in this country but all over the world. Lastly, there is the much smaller body of the "American Institute of Chemical Engineers," which has gathered together the most active of those engaged in industrial chemical work in its various ramifications.

It has been remarked that the present war is in an eminent degree a war based largely upon chemical achievement. What this means can be understood on reflection upon the enormous production of ammunition and high explosives required for daily use. Unheard-of amounts of cellulose, nitric acid, benzol, and toluol are being constantly produced for conversion into nitrocellulose for smokeless powders, and for the manufacture of picric acid and trinitrotoluol used in explosive shells and shrapnel. When the Central Powers were cut off from their supply of South American nitrate of soda they had to turn to synthetic nitric acid, made from synthetic ammonia and other sources, and these newest achievements of the chemical engineer were developed with great rapidity. The great utilization of the aeroplane in war has also led the chemist to develop the manufacture of aluminum, magnesium, and light alloys for its construction, and the gasoline motor had also to be improved for that special utilization to combine power with diminished weight.

This rapid development of the position and usefulness of the chemist means, moreover, that, after the needs of the war have ceased, he will play a very much more prominent part in the country's activities.

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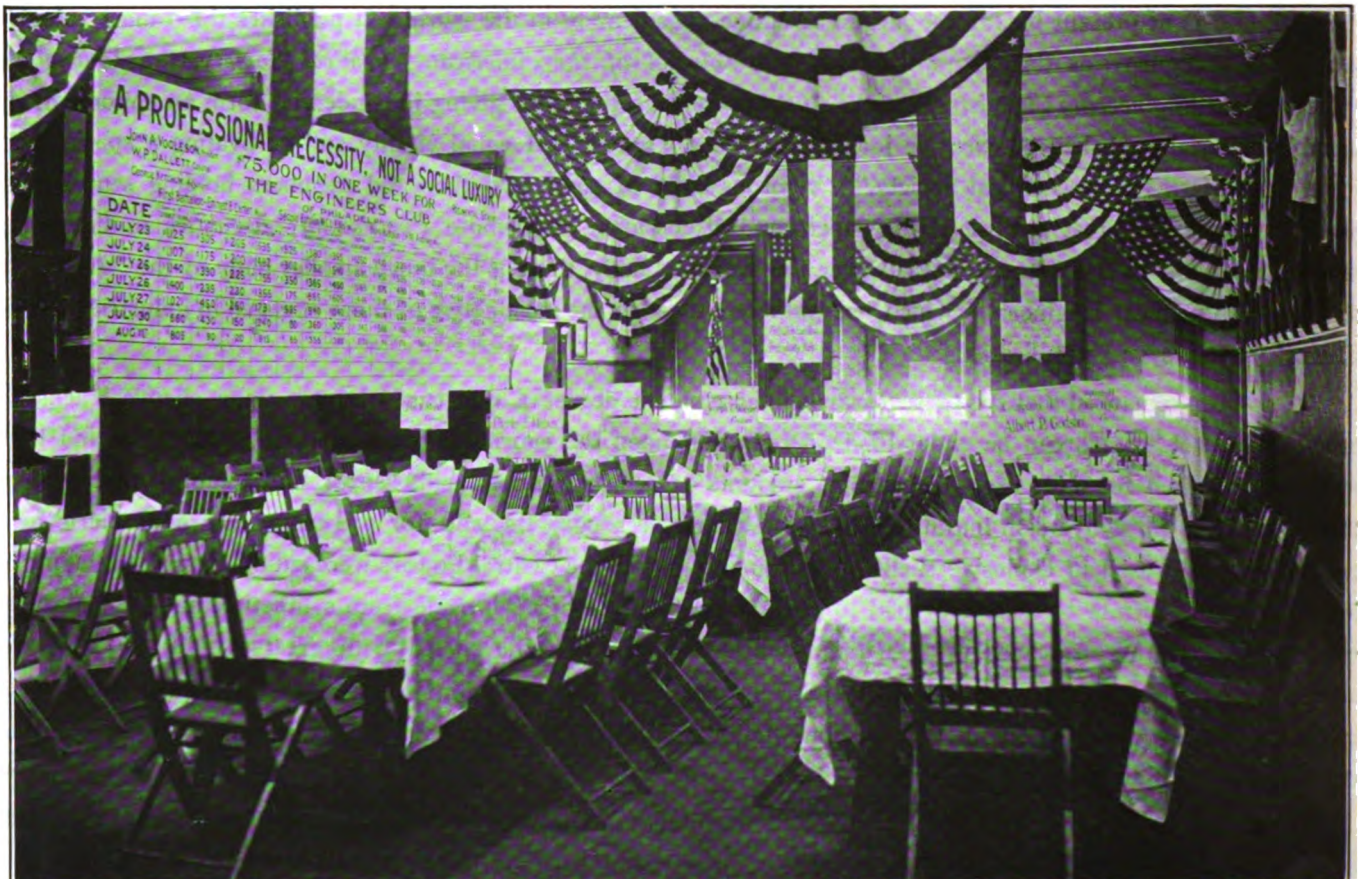
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JULY 23	\$1125	\$305	\$205	\$1635	\$525	\$380	\$355	\$1260	\$1410	\$225	\$300	\$1935	4830		4830
JULY 24	\$1007	\$175	\$200	\$1482	\$302	\$752	\$540	\$1595	\$952	\$535	\$539	\$2026	\$5104	4830	9934
JULY 25	\$1140	\$390	\$225	\$1755	\$350	\$365	\$450	\$1165	\$975	\$480	\$480	\$1935	4880	9934	14814
JULY 26	\$1400	\$235	\$220	\$1855	\$175	\$665	\$605	\$1445	\$710	\$375	\$375	\$1460	4760	14814	19574
JULY 27	\$1021	\$450	\$260	\$1731	\$985	\$940	\$1040	\$2965	\$1414	\$620	\$900	\$2934	7630	19574	27204
JULY 30	\$660	\$430	\$150	\$1240	\$80	\$360	\$305	\$745	\$580	\$180	\$595	\$1355	3340	27204	30544
AUG. 1st	\$805	\$90	\$20	\$915	\$85	\$355	\$390	\$830	\$95	\$170	\$360	\$625	2370	30544	32914
TOTALS	\$7258	\$2075	\$1280	\$10613	\$2502	\$3817	\$3685	\$10005	\$6136	\$2585	\$3549	\$12270			

THE special campaign for the Building and Equipment Fund closed on August 1, after \$32,914 had been pledged by 665 subscribers.

It is difficult to conceive of more uncomfortable conditions than those caused by the excessively hot weather which marked the week of the campaign. In spite of this handicap and the absence of many of our members from the city, the campaign was a success, considering that less than one-half of the membership was canvassed.

Too much praise cannot be given the splendid spirit displayed by the "campaigners," each of whom rendered excellent service.

The Club is deeply indebted to these men, and especially to Mr. W. P. Dallett, Chairman of the Executive Committee, who directed the activities of the campaign.

The sum subscribed is sufficient to acquire the adjoining property at 1315 Spruce Street, and to make a portion of the proposed alterations. It is not sufficient, however, to permit the carrying out of the whole plan, and for this reason an appeal has been made by letter to those who were not called upon during the campaign, but who may still wish to contribute.

The project for the Club's extension is the result of the painstaking labor of the Development Committee, of which Past President S. M. Swaab is the untiring chairman. This extension had been approved by the Board of Directors, who retired on July 1, and by the Club in its meeting of May 15. The officers and Directors, therefore, are trustees charged with carrying out the expressed desire of the Club membership. They have proceeded to execute this desire as promptly and in so far as the funds in hand will permit. The property at 1315 Spruce Street has been purchased, and construction of the enlarged auditorium and enlarged dining-room will be begun at once. The full program for the Club's extension cannot, however, be carried out until additional funds are secured.

The Engineers' Club, with its Affiliated Societies, has taken a definite forward step, and further accomplishment will depend upon the enthusiasm and persistence of each individual member.



President.

Plans showing proposed alterations to the Club House and the incorporation of the adjoining property at 1315 Spruce Street are on file in the main office. Criticisms and suggestions are invited.

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 * H. E. Tripler
 * J. Archer Turner
 * W. W. Turner
 * C. Cabell Tutwiler
 * William S. Twining

U

United Gas Improvement Company

V

* Samuel M. Vauclain
 * John A. Vogleson
 * Henry Voigt
 Vulcanite Paving Company

W

* Joseph C. Wagner
 * Samuel T. Wagner
 * R. A. Wahl
 * Chas. E. Waite
 Walsh Packing Company
 Walters, Purks & Mellon

* R. George Ward
 * H. W. Wardle
 * Bernard G. Waring
 * Harry O. Warner
 * Jacob L. Warner
 * Ambrose G. Warren
 Washburn & Granger
 * Asa P. Way
 * Stafford R. Webb
 * Walter Loring Webb
 * E. G. Weber
 * Clement B. Webster
 * George S. Webster
 * John H. Webster, Jr.
 Warren Webster & Company
 * Chas. A. Weeks
 * Morris Weldie
 * Raymond W. Welsh
 * George H. Wentz
 * F. V. Westermaier
 Westinghouse Electric Company
 Edward Weston
 * George S. Wheatley
 C. H. Wheatley
 C. H. Wheeler Mfg. Company
 * Eddy R. Whitney
 * F. E. Whitney
 * Clinton Y. Wilgus
 * Louis B. Wilson
 * J. M. Winston
 * Charles Wirt
 * Carl A. Woerwag
 * Paul L. Wolfel
 * Joseph A. Wolle
 * A. C. Wood
 Alan Wood Iron and Steel Company
 * Alan Wood, 3d
 * W. Musgrave Wood
 * Leonard Work
 * George Wright
 * Henry C. Wright

Y

* A. E. Yarnall
 * D. Robert Yarnall
 Yarnall Waring Company
 * Pope Yeatman
 * R. L. Young

Z

* Leonard Zoole

Additional subscriptions will be added to this list and published in subsequent issues of the PROCEEDINGS.

NOTE: Of the 695 subscriptions received, as of August 24, 1917, there were:

3 of \$1000 each.
 2 of 500 each.
 5 of 250 each.
 10 of 200 each.
 26 of 150 each.
 90 of 100 each.
 599 of less than \$100 each.

EARLY CHEMICAL MANUFACTURING IN PHILADELPHIA

(Continued from Page 414)

with a Dr. Edward S. Wilcox. This firm was disbanded in 1890 on the death of its founder, but in the meantime its extensive cement and plaster department, which was started in 1852 at Callowhill Street and York Ave., had been erected in 1883 into a separate business of Samuel H. French & Co. This has since developed into a very extensive cement, plaster and dry color firm, now under the leadership of Howard B. French, a son of Samuel H. French of the original French, Richards & Co. firm.

In conclusion I wish to acknowledge my indebtedness to various friends for furnishing special information and the loan of papers, books and pictures of early chemical establishments. I would specially mention

Mr. Wm. H. Bower, Mr. W. C. Carnell, Mr. Thos. S. Harrison, Dr. Ewing Jordan, Librarian of the University Club, and Mr. Spofford, the Assistant Librarian of the Historical Society, Mr. Howard B. French, Prof. Henry Kraemer of the Philadelphia College of Pharmacy, and Mr. Martin I. Wilbert, formerly in this city but now in Washington, D. C. The last named published a valuable paper in the *Franklin Institute Journal* for May, 1904, on "Early Chemical Manufactures," from which I have quoted in the preparation of this paper.

NOTE.—The Committee on Publication desire to express their appreciation to Dr. S. P. Sadtler for the Editorial which appears on Page 425 of this number.

NEED OF TECHNICAL MEN

(Continued from Page 417)

lines of engineering work, due to the cessation of large constructions and to the absolute lack of capital for important new projects of a peaceful character, the demand for young graduates of technical schools by the manufacturers of war supplies is so great that there is already a marked dearth of such assistance, which dearth will be more and more accentuated as the war progresses, and as the call for ships, guns, ammunition, airplanes, automobiles and other war paraphernalia increases.

Seventh.—Until the United States entered the war it was almost certain that most of the reconstruction work of the world would be done by American engineers, and in any case they are sure to get a fair share of it; but it seems a shame that this country should miss such a golden opportunity as that which lies before it for securing the lion's share.

Eighth.—The capacity of the old, experienced, and well-established American engineers for doing work is practically unlimited, provided that there be no shortage of young, properly-educated assistants; because most technical men of mature years have developed highly the faculty of management. On that account the average total annual amount of work engineered by such men in this country could readily be increased five fold, or, possibly even to ten fold, without causing undue overstress either physical or mental; and, consequently, the great mass of the work of world-reconstruction could emanate from the United States and be handled abroad by American engineers.

Ninth.—It is beyond question that, for the next ten years or more, engineering is everywhere going to be the most lucrative of all the professions.

Let me most earnestly implore all youths who are ready for college this fall, and who are not in any way unfitted for technical careers, to take up some branch of engineering or technology; and let me entreat the parents or guardians of such youths to exert their influence so as to induce the boys to choose that line of study for their life work. Remember, it is not only for the good of the country that I make this appeal, but also for the ultimate benefit of the young men themselves! Some reader of this communication may remark that such an appeal would possess more force if it were to come from a national engineering society than when emanating from an individual engineer. Very true! But until quite lately there has been no engineering society which draws its membership from all lines of technical activity; and the one which is now being formed, viz., the American Academy of Engineers, has not yet received from Congress the national charter for which it has applied. Were that association to-day fully organized and duly recognized by the Government, it assuredly would make such an appeal as this; and, in my opinion, that appeal would immediately be responded to by the nation, for the American people certainly are sensible enough to heed seriously any words of warning coming from a select body of the most practical men in the land.

J. A. L. WADDELL,

Consulting Engineer.

NEW YORK CITY.

—*Evening Bulletin.*

CALENDAR OF REGULAR MEETINGS

THE ENGINEERS' CLUB AND AFFILIATED SOCIETIES

1917-1918

DAY OF MONTH AND WEEK	NAME OF SOCIETY
First Monday	American Society of Civil Engineers October 1, January 7, April 1.
Second Monday	American Institute of Electrical Engineers September 10, October 8, November 12, December 10, January 14, February 11, March 11, April 8, May 13, June 10.
Second Tuesday	Engineers' Club (Junior Meeting) October 9, November 13, January 8, February 12, March 12, April 9.
Third Tuesday	Engineers' Club (except December and January) September 18, October 16, November 20, February 19, March 19, April 16, May 21, June 18.
Fourth Tuesday	American Society of Mechanical Engineers September 25, October 23, November 27, December 25, January 22, February 26, March 26, April 23, May 28, June 25.
First Wednesday	Technology Club September 5, October 3, November 7, December 5, January 2, February 4, March 6, April 3, May 1, June 5.
Third Wednesday	Engineers' Club (December and January) December 19, January 16.
First Thursday	Worcester Tech. Club September 6, October 4, November 1, December 6, January 3, February 7, March 7, April 4, May 2, June 6.
Second Thursday	American Society of Heating and Ventilating Engineers September 13, October 11, November 8, December 13, January 10, February 14, March 14, April 11, May 9, June 13.
Fourth Thursday	Society of Automobile Engineers September 27, October 25, November 22, December 27, January 24, February 28, March 28, April 25, May 23, June 27.
Third Friday	Illuminating Engineering Society September 21, October 19, November 16, December 21, January 18, February 15, March 15, April 19, May 17, June 21.

Engineers' Club Meetings at Witherspoon Hall will be as follows:

- Tuesday, September 18, **Engineers' Club** Meeting.
 - Tuesday, October 16, Joint Meeting with **American Society of Mechanical Engineers**.
 - Tuesday, November 20, Joint Meeting with **Worcester Tech. Club**.
 - Wednesday, December 19, Joint Meeting with **American Institute of Electrical Engineers**.
 - Wednesday, January 16, Joint Meeting with **American Society of Civil Engineers**.
- Members of all Affiliated Societies are invited to these meetings.**

SECRETARY'S NOTICES

REGULAR MEETING OF THE EXECUTIVE COMMITTEE.

AUGUST 14, 1917

The meeting was called to order at 12.30 P.M., with President Vogleson, Vice-President Eglin, and Director Wagner in attendance. Mr. Stockly, secretary of the Committee, was also present.

The Committee on Publication presented a report, recommending that the name of the Club publication be changed from "The Proceedings of the Engineers' Club of Philadelphia" to "The Engineering Journal, published by The Engineers' Club of Philadelphia."

Action: No action taken, and the recommendation withdrawn for the present by Mr. Wagner, Chairman of the Committee on Publication.

The Committee issued instructions to proceed with the acquisition of No. 1315 Spruce Street and to employ an architect to carry the alterations as far as the finances can be made to go. It was reported that at present there was subscribed to the Building Fund \$33,959.

The Committee extended to Major J. H. M. Andrews their thanks and appreciation for the high explosive shell he presented to the Club.

The President was authorized to appoint a committee, to be known as the Army and Navy Service Committee,

to ascertain the condition of the families of those members in active service of the Government, with a view to being of assistance to them.

The President read a letter from Mr. Kenney and one from Doctor Boehm on the subject of the Junior Section and its plans.

Action: Doctor Boehm was appointed a member of the Committee on Increase of Membership.

A communication from Dr. Ira N. Hollis, Chairman of the Engineering Council of the American Society of Mechanical Engineers, was read, on the subject of co-ordinating the engineering talent of the country, and it was the opinion of the Committee that no specific action be taken at this time, owing to the fact that most of the members of the Club were members of the national societies; and that a notice be later published in the PROCEEDINGS, requesting that those members who were not listed in the index prepared by the national society send in their names for registration therein.

The Committee ordered that the funds secured in the Building and Equipment Campaign be kept in the Third National Bank, these funds to be held in a deposit separate from the regular Club funds.

The meeting adjourned at 1.30 P.M.

H. A. STOCKLY,
Secretary.



SPECIAL NOTICES

The Committee desires to correct several typographical errors which appeared in the mathematical work on Pages 359 and 360 of the paper "Philadelphia Bridges."

The line on Page 359 which reads

$$\text{Let } J + \frac{I_2}{I_1} = \frac{s}{Jh + s} \quad r = \frac{a}{s}$$

should read

$$\text{Let } J = \frac{I_2}{I_1} \quad f = \frac{s}{Jh + s} \quad r = \frac{a}{3}$$

The equation at the top of Page 360 which now reads

$$N - \frac{2P^2}{9} = 0$$

should read

$$N - \frac{2P^2}{9} = 0$$

The official Club emblems have been received, and may be purchased at the Secretary's office.

Applications for commissions in the Signal Corps, U. S. Army, can be obtained upon request from the Secretary's office

THE attention of our members is again called to the Regulations for the Aviation Section of the Signal Officers' Reserve Corps, which appeared on Page 389 of the August PROCEEDINGS.

Blanks may be obtained upon application to the Secretary of the Engineers' Club.

COMMITTEE ON COÖPERATION FOR NATIONAL DEFENSE

GEORGE R. HENDERSON, CHAIRMAN

MEMBERS OF ENGINEERS' CLUB WHO HAVE BEEN CALLED INTO SERVICE IN THE ARMY OR NAVY OF THE UNITED STATES AS OF AUGUST 24, 1917

NAME	RANK	CORPS	LOCATION
ANDERS, D. W.	Captain	Engineers' Officers' Reserve	
ANDREWS, J. H. M.	Major	1st Penna. Engineers	Camp Hancock, Augusta, Ga.
ASPLUNDTH, E. T.	Captain	1st Penna. Engineers	Belvoir, Va.
BRADFORD, J. S.	Captain	1st Regt. Penna. Engineers	Camp Meade, Admiral, Md.
BREEN, J. W.	Captain	Engineers' Officers' Reserve	
BROADHEAD, ALEX.		"B" Company, Engineers' Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
BRYANT, C. M.		Naval Coast Defense	Philadelphia Navy Yard
BUTLER, E. N.	2nd Lieutenant	1st Regt. Penna. Engineers	Camp Meade, Admiral, Md.
CACCAVAJO, JOS.	Captain	Engineers' Training Camp	Washington, D. C.
CRAMPTON, G. S.	Major	Medical Corps, National Guard	Fort Benjamin Harrison, Ind.
DONNELLY, J. B.	1st Lieutenant	1st Regt. Penna. Engineers	Camp Hancock, Augusta, Ga.
ELCOCK, CHAS.	1st Lieutenant	1st Regt. Penna. Engineers	Camp Meade, Admiral, Md.
FULWEILER, J. E.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
GETZ, RALPH F.		Engineers' Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
GWILLIAM, MARK R. M.	2nd Lieutenant	21st U. S. Infantry	
HALL, W. A.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
HOLLENBACK, E. E.	Major	1st Pennsylvania Infantry	Camp Hancock, Augusta, Ga.
LAWRENCE, G. E.	Lieutenant J.G.	Naval Coast Defense	Philadelphia Navy Yard
LAWSON, T. W.	Lieutenant	1st Penna. Infantry	Camp Hancock, Augusta, Ga.
MCCORD, J. B.	Captain	Ordnance Officers' Reserve	War Department, Washington, D. C.
MYERS, W. T.	2nd Lieutenant	U. S. Cavalry	
NEWLIN, E. M.		Fort Niagara Officers' Training Camp	Fort Niagara, N. Y.
NIXON-MILLER, W.	Captain	Engineers' Officers' Reserve	Belvoir, Va.
O'CONNOR, C. P.	Captain	19th Regt. Reserve Engineers	American Expeditionary Forces, France
PERRY, EDWARD		Quartermaster's Officers' Reserve	Camp Lee, Petersburg, Va.
REED, R. W.	Private	"E" Company, Engineers' Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
RIDGWAY, J. J.		Company 7, Officers' Reserve Training Corps	Fort Niagara, N. Y.
RITCHIE, J. M.	Captain	Quartermaster's Officers' Reserve	Washington, D. C.
SANVILLE, L. F.		2nd Artillery, Penna. Troops	Camp Hancock, Augusta, Ga.
SHUSTER, W. H., JR.		Fort Niagara Officers' Training Camp	Fort Niagara, N. Y.
TILLSON, P. E.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
WARFEL, A. C.	2nd Lieutenant	Engineers' Officers' Reserve Corps	
WARFEL, J. P.	Senior Lieut.	U. S. Naval Reserve Force	
WHITE, W. M.	1st Lieutenant	1st Regt. Penna. Engineers	Camp Meade, Admiral, Md.
WILD, H. J.	Captain		War Department, Washington, D. C.
WILSON, L. B.	Private	Company I, 1st Pennsylvania Infantry	Rockville, Pa.
WORTH, J. G.	Captain	Quartermaster's Officers' Reserve	Camp Wheeler, Macon, Ga.

REQUEST FOR INFORMATION

THE COMMITTEE REQUESTS THAT THE MEMBERS OF THE CLUB INFORM THE COMMITTEE OF THEIR ADMISSION TO THE MILITARY OR NAVAL SERVICE.

THE COMMITTEE WOULD ALSO BE PLEASED TO RECEIVE SUGGESTIONS FROM MEMBERS WHO HAVE ENTERED THE SERVICE. PLEASE ADDRESS COMMUNICATIONS TO THE COMMITTEE ON COÖPERATION FOR NATIONAL DEFENSE.

COMMITTEE ON MEMBERSHIP

D. ROBERT YARNALL, CHAIRMAN

CANDIDATES FOR MEMBERSHIP

Members having knowledge of the candidates are invited to submit to the Committee on Membership before September 10 a confidential expression of opinion as to the eligibility of the candidates; all communications to be addressed, "Chairman of the Committee on Membership, Engineers' Club, Philadelphia," marked "Confidential."

All applications are on file at the Club and can be referred to by any member.

FOR ELECTION TO ACTIVE MEMBERSHIP

EDMUND DE FOREST CURTIS

Five Points, Wayne, Pa.

Assistant Superintendent, Blast Furnace Department, Alan Wood Iron and Steel Company, Swedeland, Pa.

Proposed by Francis H. Gilpin and F. B. O'Connor.

RICHARD HOWELL

Devon, Chester Co., Pa.

Secretary and Treasurer, Chelton Ice Manufacturing Company, Philadelphia.

Proposed by Joseph C. Wagner and Walter Loring Webb.

WALTER M. JOYCE

2117 Chestnut St., Philadelphia

Engineering Department, Pennsylvania Railroad, Philadelphia.

Proposed by J. W. Silliman and J. W. Costello.

CHARLES ARTHUR MEADE

Thirty-fifth St. and Gray's Ferry Road, Philadelphia

Vice-President, Harrisons, Inc. (Subsidiary E. I. du Pont de Nemours & Co., Wilmington, Del.)

Proposed by Walter Blackson and Jacob L. Warner.

HUGO SCHLATTER

Hercules Powder Company, Wilmington, Del.

Smokeless Powder Expert, Hercules Powder Company, Wilmington, Del.

Proposed by George M. Norman and Walter Blackson.

SIGFRID E. R. SIVEN

1736 Erie Ave., Philadelphia

Chemist, The Geo. W. Blabon Company, Philadelphia.

Proposed by Earle B. Schaefer, John P. Mudd, and George A. Richardson.

HERBERT TALLEY

Hercules Powder Company, Wilmington, Del.

Chief Engineer, Hercules Powder Company, Wilmington, Del.

Proposed by George M. Norman and Walter Blackson.

FOR ELECTION TO JUNIOR MEMBERSHIP

ROBERT WILLIAM HENDEE

Coulter Inn, Germantown, Philadelphia

Engineer, Midvale Steel Works.

Proposed by John P. Mudd and Emmett B. Carter.

DAVID EVERETT WAITE

3705 Walnut St., Philadelphia

Assistant Metallurgist, Tindel-Morris Company, Eddystone, Pa.

Proposed by D. K. Bullens and L. K. Carroll.

WILLIAM ROBERT WATT

4318 North Eighth St., Philadelphia

Mechanical Estimator, Midvale Steel Company, Philadelphia.

Proposed by John P. Mudd and Emmett B. Carter.

SITUATIONS VACANT

Draftsman. Experienced structural steel detailer in contractor's office. No attention paid unless salary, age and full experience are stated. Apply Engineers' Club, No. 163-A.

Engineer experienced in the design and construction of power plants wanted, for public utilities work, including the

ability to estimate accurately the cost of such construction. Also experienced in writing up reports on proposed construction work, and with sufficient ability to carry on the entire work and settle all questions that may come up in the course of construction. Apply Engineers' Club, No. 164-A.

POSITION WANTED

Master mechanic desires position. Thoroughly familiar with large maintenance and construction work. Apply Engineers' Club, No. 161.



AMERICAN SOCIETY OF MECHANICAL ENGINEERS .: PHILADELPHIA SECTION

LEWIS F. MOODY, Chairman. JOHN P. MUDD, Secretary Midvale Steel Company, Nicetown, Pa.



A MEETING of the officers and Executive Committee was held at the Engineers' Club on Monday, August 27. At this meeting the general outline for the coming year was gone over. The prospects for a successful year are unusually bright. A number of the papers will be upon problems developed by America's entry into the world war.

Mr. D. Robert Yarnall, who is chairman of the New York Committee on Sections, was present. He empha-

sized the importance of the work of the sections, particularly the Philadelphia section.

In a letter to the Philadelphia section a particular paper by Mr. W. P. Barba on "Industrial Safety and Principles of Management" was cited as a case of a very meritorious paper which was first presented before the local section, later at the annual meeting in New York, and finally published in the *A. S. M. E. Journal*



AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS .: PHILADELPHIA SECTION

NATHAN HAYWARD, Chairman

H. MOURADIAN, Secretary, 1631 Arch Street



THE OCTOBER MEETING

THE October meeting will be a regular Institute meeting, and will be held in Philadelphia, October 8, 1917. The general subject of the meeting will be "Industrial Research." A discussion of industrial research should prove highly profitable and practical just at this time.

Papers will be read by Mr. C. E. Skinner and Dr. F. B. Jewett on "The Influence of Industrial Research on the Development of Electrical Industries," and by Dr.

A. E. Kennelly on "The Contribution of Universities to Industrial Research." We are in correspondence with a fourth speaker, but are not yet in a position to announce his name or the subject of his paper.

As this is a regular meeting of the National Society, American Institute of Electrical Engineers, a large out-of-town attendance is expected. There will be afternoon and evening sessions, with an informal dinner between.

The place of meeting will be announced in the October issue of the PROCEEDINGS, together with a notice of the exact titles of the papers to be presented.

CODE OF LIGHTING

(Continued from Page 423)

analyzed for their spectral transmission of invisible radiation. Protective measures should also be taken to prevent on-lookers from being unduly exposed to such eye dangers, by enclosing the welding operations with suitable partitions. These general remarks apply with equal force from the standpoint of those handling the operations to such other cases as the testing of arc lamps, inspection of hot metal, and similar cases.

SECTION XVI. AUXILIARY SYSTEMS FOR SAFETY.—The auxiliary system of lighting called for in Article XI of the Code is a safety-first precaution which is insisted upon in a large proportion of the 1200 buildings coming under the control of the Bureau of Water Supply, Gas and Electricity in New York City, particularly such buildings as are occupied by large num-

bers of people. The same precaution is now observed by the Bell Telephone Company's offices fairly generally thruout the country, also by a large number of private manufacturers and by local ordinances compelling all types of amusement places to take this precaution.

SECTION XVII. GOOD AND BAD LIGHTING COMPARED.—In order to give an idea of good and bad lighting, Figs. 13, 14, 26, 27, 28, and 29 are shown. These illustrations indicate the use of various types of lamps and a reference to the captions under the illustrations will bring out the weak points of the poorly lighted spaces, as well as the points of excellence in those cases which are designed in conformity with good illumination practice.

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"I have internal pain."

J'ai des douleurs internes (French)
Jay day doo-lerrrs an-tairn (Pronunciation)

OR

You want to know the French for *password*.
Turn to Military Terms and you find—

"Password"
Le mot d'ordre (French)
Ler mow dor-da (Pronunciation)

It's all so clear, so easy and so practical that it hardly seems real.

This little book should not be confused with the usual phrase books compiled for holiday-tourists. This is gotten up especially for the Soldier and only those words and phrases likely to be of use to him are included.

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THE JOURNAL OF THE ENGINEERS' CLUB OF PHILADELPHIA

AND AFFILIATED SOCIETIES

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Secretary to the Committee on Publication: R. F. VICKERS



XXXIV-10

OCTOBER, 1917

No. 155

CONTENTS OF THIS ISSUE

	PAGE		PAGE
A Discussion of the Fundamental Principles of Water-Works Valuation.....	441	George S. Cheyney—Obituary.....	486
By J. W. LEDOUX		Secretary's Notices	487
The Pennsylvania Electric Code.....	449	Supplementary List of Subscribers to Building and Equipment Fund.....	489
By JOHN PRICE JACKSON		Special Notices	489
Electric Code—Adopted by the Industrial Board, Pennsylvania Department of Labor and Industry, Operative on and after July 1, 1917.....	450	Calendar of Regular Meetings of The Engineers' Club and Affiliated Societies—1917-1918.....	490
Use of Mean Sea Level as the Datum for Eleva- tions.....	477	Committee on Membership.....	491
Extracted from Special Publication No. 41, U. S. Coast and Geodetic Survey		D. ROBERT YARNALL, Chairman	
Officers, Directors, Standing and Special Committees of Engineers' Club.....	480	Positions Open and Positions Wanted.....	491
Editorial	481	Committee on Coöperation for National Defense... ..	492
Committee on Papers.....	482	GEORGE R. HENDERSON, Chairman	
LEWIS H. KENNEY, Chairman		American Institute of Electrical Engineers.....	495
Abstract of Paper "The War's Effect on Merchant Shipbuilding".....	483	Technology Club of Philadelphia.....	495
By HOMER L. FERGUSON		American Society of Mechanical Engineers.....	496
Club House Improvements.....	484	American Society of Heating and Ventilating Engineers	496
By S. M. SWAAB		Index to Advertisers.....	ix

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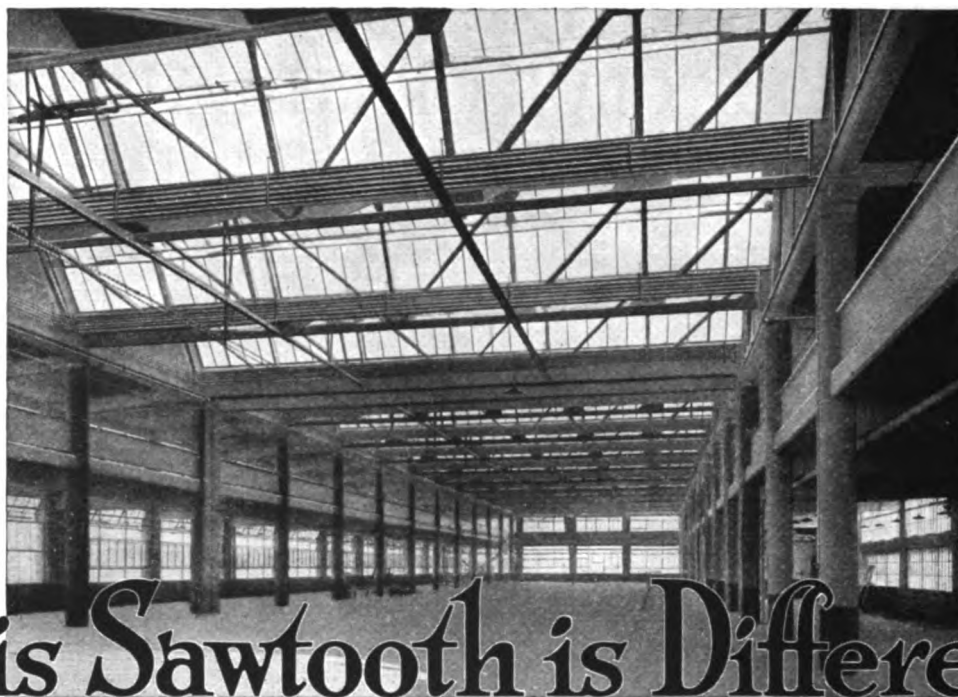
Contributions on topics of interest to the members of the Club and Affiliated Societies are cordially invited. All matter for publication, including advertising copy, must be in the hands of the Editor by the 15th of the month for the issue of the following month.

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NOTE. The Club as a body is not responsible for the statements and opinions advanced in its publications.

Entered as matter of the Second Class, at the Post Office, Philadelphia, Pa., under the Act of Congress, March 3, 1879.



This Sawtooth is Different-

You have seen sawtooth roofs, but never—unless you have been on this Goodrich top floor—have you seen the last word in sawtooth *ventilation*, as well as lighting!

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First, the sawtooth continuous sash is top-hung and unbroken, therefore rainproof when open. Stale air can escape, rain or shine.

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Power House Type
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and side walls
Pond Operating Device for long
lines of sash
Lupton Rolled Steel Skylight
Lupton Steel Partition and
Doors
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PHILADELPHIA, PA.

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A DISCUSSION OF THE FUNDAMENTAL PRINCIPLES OF WATER-WORKS VALUATION

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PAST PRESIDENT, THE ENGINEERS' CLUB

THE subject of valuation of a public utility, such as a water-works property, has been receiving much attention during the past few years, and the views of many experienced engineers, economists, public service commissions, and courts have been placed upon public record; so there should be established by this time a fairly definite method, general rules, and a line of procedure available which would be recognized by the tribunals as sound. Unfortunately there is as yet no unanimity of view, so that each case has to be treated on its merits by the valuator, with a fair chance that the court or commission will discredit the whole argument.

There are several reasons why the matter is in such a chaotic state. One school of thought holds that the valuation should be the same, no matter for what purpose it is being determined; another, that there are several materially different valuations of a public utility, depending upon circumstances.

The writer agrees with the latter view.

The only reason for presenting a paper on this subject is because of the diverse views that are evident in many of the rulings of commissions and courts, and the writer believes it is the duty of every engineer that has positive convictions in the matter to express them publicly to aid in causing the adoption of laws that are based on rational principles of justice.

If rates are to be established, the valuation should be based on the fair and legitimate investment. If the financial transactions have been honest and the works have been built and operated according to average or ordinary practice, and the book records are in good shape, the historical cost should be taken and the rates should be such as will enable the utility to receive a fair return on its investment from the beginning; so, therefore, if the utility has not as yet received a fair return and is depending upon the future to attain that object, the past losses must be added to the historical cost.

The logical method of procedure is to tabulate for each year,

The plant cost (a),
The operating expenses (b),
The estimated depreciation on
the physical plant (c),
The gross revenue (d),
The fair return (e), and
The valuation (v).

Then $v = (a + b + c - d) \frac{p}{100}$
and $v = a + b + c + e - d$,
where p is the fair return
decided upon as a percent-
age on the investment.

By this process it is seen that a reduction of any of the items— a , b , c , e —or an increase of the item d , will decrease the valuation, and *vice versa*. If the utility has earned a fair return and no more,

$$b + c + e = d, \text{ and} \\ v = a.$$

If it has earned more than a fair return, v will be less than a , and if it has earned less than a fair return, v will be more than a .

Under this plan no allowance would be made for accrued depreciation, obsolescence, or fluctuation of value of real estate, water rights, or other property. Neither would allowance be made for service pipes or street pavements, unless their cost were borne by the water company.

In the writer's judgment, this is the method of determining the valuation that should be used for the establishment of rates or where the property is being condemned by the municipality.

The following are some of the reasons for this conclusion: Most water-works systems were established before the advent of state control and regulation of rates. The owners knew that the works would have to go thru a period of development and could not pay for a considerable number of years. They had reason to believe they would eventually pay a sufficient return to make up for early losses, and, therefore, if the city should

ENGINEERS' CLUB OF PHILADELPHIA

condemn, they would receive at least the past cost plus a reasonable rate of return on said cost; otherwise the city would be taking private property without just compensation.

The market value of a property is dependent upon its future net revenue, which depends upon its rates. Without state regulation these elements of market value are capable of being predicted by water-works builders and investors with as much certainty as with other industries. But just as soon as the state undertakes to fix rates it must, presumably, do so with justice. That means that the public shall be protected against undue profits to the water company and the company shall be protected against loss, which will be the case unless it earns a fair return on the investment corresponding to water-works practice. Hence the valuation must be based on investment and not on estimated cost of reproduction at present prices. Neither can it be based on market value, because the market value cannot be established until the rates have been fixed for a long period in the future.

Evidently there are serious difficulties connected with the practical application of this method, otherwise it would be more universally recommended for the two conditions above cited. A few of these difficulties are as follows: The accounts of the water company may be lost or manifestly in error. The construction and operation of the works may have been grossly mismanaged. The

cost of the physical plant and of operation may have been much too high or too low in comparison with ordinary practice. The property may have changed hands at a price that was grossly different from a fair valuation. For all these cases the valuator will have to use his best judgment to supply missing or defective data.

Assuming that all the items represented in the formula by *a*, *b*, *c*, and *d* are satisfactorily determined, what shall be taken for *p*, the percentage of fair return?

A public water-works, whether owned by a private company or a city, is one of the most important and vital elements upon which the health and welfare of the community depend. The responsibility for its safe operation is great, and any failure in the performance of its functions is damaging to the community depending upon it. To be operated well and continuously, its financial success must be certain. To maintain the desired standards and well provide for the growing demands, money must be readily available. This means that investors in its stocks or securities must be assured of fair returns, and that there is no danger of public confiscation by undervaluations or inadequate rates.

Heretofore the percentage of returns on this class of property has been far less than on other public enterprises of less vital importance, and there is a tendency on the part of the public service commissions to squeeze down the valuations and consequent return on the in-

TABLE I

Valuation Based on the Actual Cost, Including a Fair Return of 8 Per Cent. on the Investment, and 1 Per Cent. Depreciation

Year	1 Plant cost and improvements from year to year	2 Operating expenses, including taxes and insurance but not interest or depreciation	3 Gross receipts from operation	4 Total expenses (1+2+7)*	5 Total expenses minus receipts (4-3)	6 Fair return 8 per cent. plus 1 per cent. depreciation = 9 per cent. on column 5	7 Valuation of plant at end of each year (5+6)
1889	\$42,000.00			\$42,000.00	\$42,000.00		\$42,000.00
1890	6,535.40	\$2,025.39	\$2,249.67	50,560.79	48,311.12	\$4,347.99	52,659.11
1891	2,879.92	1,885.36	3,606.66	57,424.39	53,817.73	4,843.59	58,661.32
1892	6,936.30	1,819.99	5,101.43	67,417.61	62,316.16	5,608.43	67,924.63
1893	1,903.61	1,955.96	6,186.59	71,784.20	65,597.61	5,903.78	71,501.39
1894	1,425.85	1,559.92	7,128.58	74,487.16	67,358.58	6,062.26	73,420.84
1895	7,780.83	2,020.84	8,152.77	83,222.51	75,069.74	6,756.27	81,826.01
1896	1,607.65	3,437.83	9,056.45	86,871.49	77,815.04	7,003.35	84,818.39
1897	10,747.41	3,025.36	9,716.35	98,591.16	88,874.81	7,998.73	96,873.54
1898	1,290.32	4,470.75	9,562.28	102,634.61	93,072.33	8,326.50	101,398.83
1899	1,862.82	2,089.35	10,413.49	105,351.00	94,937.51	8,544.37	103,481.88
1900	532.78	3,479.73	10,803.68	107,494.39	96,690.71	8,702.16	105,392.87
1901	2,870.80	4,596.83	12,774.14	112,860.50	100,086.36	9,007.77	109,094.13
1902	3,279.23	4,151.63	11,627.44	116,524.99	104,897.55	9,440.78	114,338.33
1903	2,779.56	5,252.57	13,207.14	122,370.46	109,163.32	9,824.70	118,988.02
1904	4,322.97	6,284.04	14,363.17	129,605.03	115,241.86	10,371.77	125,613.63
1905	1,636.30	5,885.11	14,272.20	133,135.04	118,862.84	10,697.65	129,560.49
1906	7,262.56	6,196.80	16,257.90	143,019.85	126,761.95	11,408.57	138,170.52
1907	26,412.27	8,209.25	17,772.66	172,792.04	155,019.38	13,951.74	168,971.12
1908	217.71	7,330.24	17,903.87	176,519.07	158,615.20	14,275.37	172,890.57
1909	522.41	6,631.18	19,253.54	180,044.16	160,790.62	14,471.15	175,261.77
1910	6,543.13	7,585.01	19,277.86	189,389.91	170,112.05	15,310.08	185,422.13
1911	11,816.56	4,615.73	21,141.01	201,854.42	180,713.41	16,264.21	196,977.62
1912	3,560.60	5,464.42	23,856.75	206,002.64	182,145.89	16,393.13	198,539.02
1913	7,250.51	8,785.21	26,599.76	214,574.74	187,974.98	16,917.75	204,892.73
1914	13,929.53	6,389.78	27,204.29	225,212.04	198,007.75	17,820.70	215,828.45
1915	14,602.90	9,646.46	27,403.57	240,077.81	212,674.24	19,140.68	231,814.92
1916	11,518.71	6,698.41	28,775.06	250,032.04	221,256.98	19,913.13	241,170.11
1917	369.93	2,036.63	1,080.62	243,576.67	242,496.05	5,456.16	247,952.21

* Figures for column 7 are for end of previous year.

(Valuation as of January 1, 1917, by this method, \$241,170.11.)

vestment to figures that are a grave menace to this class of property.

Recognizing this condition, the holders of wealth are reluctant to make such investments unless there be assured earnings far in excess of a legal rate of interest. Men experienced in water-works management and finances refuse to purchase these properties except on a nine or ten per cent. basis. As a consequence, it will be impossible to make necessary improvements to meet the growing demands of the communities, unless the commissions and tribunals make it their business to adopt an entirely different attitude, such that the water-works investments will again be considered as attractive and safe as they were prior to the time when they came under commission regulation.

It would therefore seem that for the present, at least, eight per cent. should be taken as a fair return. For future years, when water-works investments are again looked upon as stable and safe under commission ruling, it may be that a much lower per cent. will attract capital, even approximating as low as obtains for municipal securities.

To make the process of valuation, outlined in the table on the preceding page, as simple, definite and specific as possible, a typical case of a small water-works plant is taken as an illustration. It happens to be a fairly successful works, which has actually earned an average of over seven per cent. on the investment from the beginning.

The foregoing discussion refers to the case of establishing rates or condemnation of the plant by the municipality. The valuation so determined is not at all based on economic or market *value*, and therefore cannot be considered as synonymous with what has been designated as "fair value," but is more properly termed, "fair valuation," or "just valuation," and is applicable to those cases, not only in which the utility is under government regulation as to rates or subject to condemnation, but where the exercise of either one of these functions is the purpose of the valuation.

We next come to the case wherein a municipality desires to acquire the utility. It may have the option of negotiating with the owners of the utility, of exercising its right of eminent domain or of building its own plant. Let us assume the municipality prefers not to condemn on account of the danger of too high a valuation, so that a satisfactory price must be agreed upon or the municipality builds its own works. The municipality calls in an experienced valuator and inquires of him as follows: "What can we afford to pay for the utility rather than build our own works?" The valuator naturally proceeds to estimate, at present prices, the cost of construction of an exactly equivalent plant, from which he deducts a proper allowance for accrued depreciation. To the remainder he adds the value of the acquired revenue and obtains a valuation based on the cost of reproduction—usually designated as "the cost of reproduction less depreciation plus going value." This method is entirely

different from the first, and the resulting valuation is likely to be materially different. If the city did not have the right to build its own plant without first buying or condemning the existing plant, there would seem to be no logical justification for this method of valuation.

Let us assume, however, first, that the city has the right to build its works but cannot prevent the water company from continuing to operate, and, second, it has the right to build its own works, and as soon as the new plant is completed it can prevent the water company from continuing its business. The cost of construction will be the same in each case, but the "going value" will be materially different. In the first case it may be impossible for the city to acquire all, or even a substantial portion, of the revenue. So the city can afford to pay the water company a high price for the existing revenue rather than be subject to disastrous competition and economic loss. In this case the "going value" will be a maximum.

In the second case the city is sure to secure all the revenue within a few years after the new works are completed. If there is no other way to obtain water, most of the people will connect up the first year after the beginning of operation, and every one of the old consumers will be a patron of the new works within two or three years. However, the usual case is where the people can obtain water from wells or cisterns, in which case it may be several years before they are all connected up.

To determine or calculate what the "going value" should be for either of these cases, it is necessary to make a comparison of the financial operation of each plant from the present up to the time when the new plant is receiving the same gross and net revenues as the old plant is then receiving. The annual differences in favor of the old plant reduced to a present-worth basis will be the "going value." Some broad assumptions have to be made—the length of time required to build the new plant, the annual operating expenses, depreciation, interest, the gross revenue for each plant up to the time at which they are equivalent, and the value of money to be used in calculating the present worth. Most of these elements require judgment and at best are subject to uncertainty, but the computation is nevertheless perfectly legitimate and likely to reach much nearer the truth than to guess at the "going value" without any other basis of comparison. The prognostication of the future is very much aided by the graphical method. Curves are drawn to indicate the variation of gross revenue and operating expenses for the old plant, and these are extended into the future years, preferably by straight lines. From these straight lines an equation of the operating expenses is derived in the form

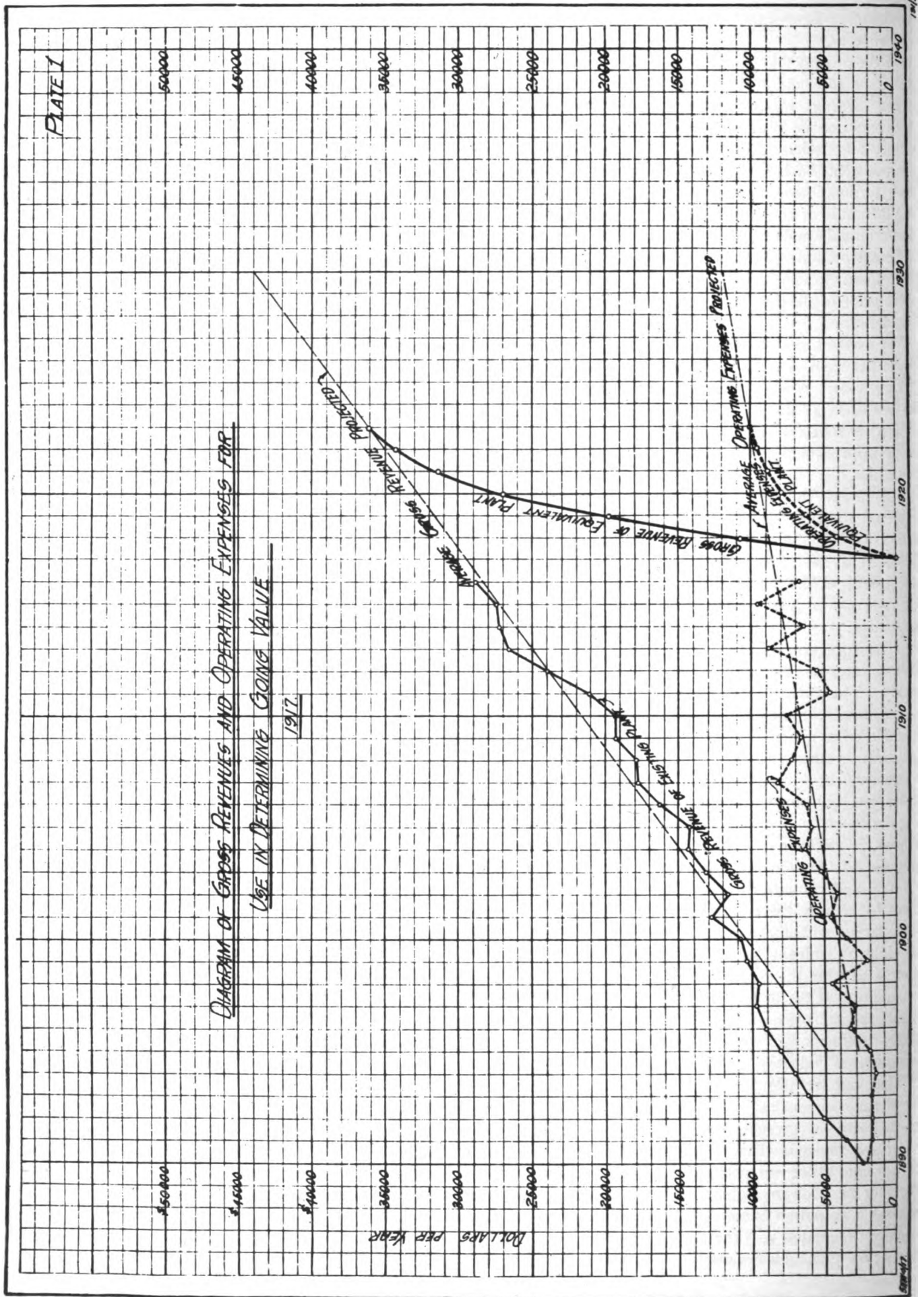
$$o = a + bR, \text{ in which}$$

o is the annual operating expenses,

R is the gross revenue,

a and b are constants.

Substituting known values for o and R for two points on each of the straight lines, the constant values of a and b are obtained.



Next tabulate the estimated annual gross revenue for the new plant, from which the equation may be used to calculate the operating expenses. We now have sufficient data to complete the table. To reduce the net revenue differences to present worth, it would seem that for these cases the rate of interest which the municipality has to pay for money should be used rather than that which the water company should receive as a fair return.

The valuation so obtained will represent what the city can afford to pay rather than build its own plant.

It is evident that this method ought to produce the same result when it is approached from the water company's side. The question would then be, "What can it afford to take rather than let the city build its own works?" The answer would naturally be, "It cannot expect to receive more, and it should not receive less, than the city can afford to pay, and, hence, precisely the same method should be used and the same rate for money to calculate present worth."

In order to make the method of calculating "going value" more clearly understood and rationally presented, we have shown a typical calculation in Table III. We have assumed the physical cost of the plant to be \$235,265. The diagram herewith shows the gross revenue and operating expenses and curves of the corresponding estimated figures for the equivalent plant. We assume that it would take a year to complete the construction of an equivalent plant, and that six years after the plant is completed it will have the same earnings and operating expenses as the present plant. The variations would be as follows:

TABLE II

At the end of the first year after completion 30 per cent. of the final gross revenue.

At the end of the second year after completion 35 per cent. of the final gross revenue.

At the end of the third year after completion 75 per cent. of the final gross revenue.

At the end of the fourth year after completion 87 per cent. of the final gross revenue.

At the end of the fifth year after completion 96 per cent. of the final gross revenue.

At the end of the sixth year after completion 100 per cent. of the final gross revenue.

From the equation

$$o = a + bR,$$

taking values of o and R from the straight lines of the diagram, a and b become \$1660 and 0.232 respectively, so that the final equation becomes:

$$o = \$1660 + 0.232R.$$

From Table II the values of R are obtained and substituted in the equation, and the values for o are calculated for the equivalent plant.

We now have all the data for the gross revenue and operating expenses of the equivalent plant.

If the present plant is to be purchased, we will assume, afterwards to be verified, that the price will be \$276,740, but if a new plant were built, which would require approximately a year for its construction, the cost would be \$235,265, and the difference between the two is the "going value." Assuming, first, that the old plant would be purchased, the gross revenue and operating expenses, from the diagram, are found to be as shown at the left side of Table III, and the interest on the purchase price per year at 5 per cent. will be \$13,837, so with these data we obtain the annual net return over interest charges. With the equivalent plant we assume that \$235,265 for construction is borrowed uniformly during the first year, and therefore the interest during the year will be 5 per cent. on the total amount for six months. Now let us assume that we apply each year to "capital added to make up deficit" a sufficient amount so that the net return over interest on amounts borrowed at 5 per cent. will be exactly equivalent to the net return over interest on the present plant. If, at the end of six years, the entire difference between \$276,740 and \$235,265 is used up for this purpose, then we will have made a correct assumption as to the value of the old plant, and the difference between that and the cost of construction of the new plant will be the "going value." The following table (No. III) will make this clear:

It will, of course, be understood that several trial calculations for the "going value" must be made, and the table worked out from the existing data in each case until we find a sum that will be just sufficient, so that at the end of six years the two plants will be earning the same without any extraction for "capital added to make up deficit." In this case the difference between the purchase price of the old and the cost of construction of the new plant is \$41,479, representing the "going value," and the steps are clearly shown in the table.

The next important case is where the city neither has the right to condemn, grant a new franchise, nor build its own works, so long as the water company furnishes good water and service, and the rates are established for a long and indefinite term of years. The city or some outsider desires to acquire the plant; what should be the process of valuation? Evidently an entirely different principle applies, for the water company cannot be forced to sell, cease operation, or relinquish any of its business. An appraiser is called in to make a valuation. After considering all the circumstances of the case he will naturally come to the conclusion that this is a case where the "market value" method applies. He is not interested in what it will cost to reproduce the plant, but he is interested in what it will cost to operate it, maintain it, and make the necessary renewals and improvements. He wants to know how the revenue is varying from year to year and what it is likely to be in the future. His inquiry does not extend beyond thirty or forty years in the future, because he recognizes such remoteness to be in the realms of posterity. He then proceeds to draw graphs of the operating expenses during the past years and extend them

ENGINEERS' CLUB OF PHILADELPHIA

TABLE III
Calculation of "Going Value"

GIVEN DATA <i>Present Plant</i>						CALCULATED DATA <i>Equivalent Plant</i>					
Date	Capital invested to buy old plant	Gross revenue	Operating expenses	Interest on capital	Net return	Capital invested in plant	Capital added to make up deficits	Gross revenue	Operating expenses	Interest on capital	Net return
1917											
January 1....	\$276,740	.....	.....	.....	.....						
July 1.....	276,740					\$235,265					
December 31	276,740	\$29,400	\$8,500	\$13,837	\$7,063		\$12,945			\$5,882	\$7,065
1918											
December 31	276,740	30,500	8,700	13,837	7,963	.....	13,733	\$10,800	\$4,160	12,410	7,963
1919											
December 31	276,740	31,700	9,000	13,837	8,863	.....	8,400	19,800	6,240	13,097	8,863
1920											
December 31	276,740	32,700	9,300	13,837	9,563	.....	3,990	27,000	7,910	13,517	9,563
1921											
December 31	276,740	33,900	9,500	13,837	10,563	.....	1,820	31,400	8,940	13,717	10,563
1922											
December 31	276,740	35,100	9,800	13,837	11,463	.....	591	34,300	9,620	13,808	11,463
1923											
December 31	276,740	36,100	10,100	13,837	12,163	.....	.....	36,100	10,100	13,837	12,163

"Going value" = \$41,479

Valuation of plant = \$235,265 + \$41,479 = \$276,744

forty years into the future. To find out how the plant is likely to grow, he makes a similar graph of the plant costs. This curve will also be useful from which to figure depreciation. To determine the maintenance and necessary renewals, it will be sufficient and safe enough to make from the beginning an annual allowance of say eight-tenths of one per cent. on the total plant cost up to the end of the previous year, for if the plant is earning more than 5 per cent. the allowance for depreciation can be invested in its improvements.

He now makes a graph for past and future gross revenue, and this completes the data from which to tabulate the annual net revenues for the next thirty or forty years. This is preferably divided into two parts, one of which is the portion that applies to the plant as existing at present. The latter figures are determined by taking the earnings in proportion as the present plant cost is to the future total plant costs; that is, earnings applying to present plant for any year are to total earnings for that year as present cost is to total cost for that year. If money in the water-works business is worth 8 per cent., he proceeds to reduce these future annual net revenues to present worth, and the sum will be a valuation from which should be deducted the accumulated depreciation up to the present time.*

The reason why the accumulated depreciation up to the present time must be deducted is that we are starting with a plant that has suffered a certain amount of depreciation. If this depreciation be figured from the beginning on a sinking-fund basis, at a fixed per cent. on the cost, we cannot be justified in figuring it in the future at the same rate of per cent. unless we place the accumulated depreciation up to the present time in a depreciation fund to the credit of the water company, or, what is

exactly equivalent, to deduct that amount from the price of the plant, but the future depreciation must be figured on the plant cost the same as if no deduction had been made.

The following table (IV) shows a calculation for the market value of the property according to the method just described. At the present time the historical cost of the existing physical plant is assumed to be \$204,399, or, in round figures, \$204,000. The table shows the gross earnings in the future, both for the present plant and the necessary additions to it for capital account.

Naturally, the valuator will make a critical examination of the territory, of the adequacy and public satisfaction of the water supply and service, have some of the pipes taken out to examine their condition, and make a careful inspection of the entire physical plant and its conditions, and from this inspection make such modification of his calculated value as his judgment indicates to be advisable.

While these three are the most important conditions for which valuations are required—and it has been shown that each requires a different viewpoint, different economic principles of appraisal, and leads to essentially different results—there are still other purposes of valuation, for which the methods to be pursued are not so obvious.

Suppose a water company desires to create a mortgage on its entire property or issue stock up to the warrantable limit of its valuation, upon what principle shall the valuation be derived? The usual case is where the water company must go before the public service commission for authority for such procedure, and said commission wishes to establish such a valuation as will protect alike the water company and those who may invest in its securities. It would seem that for this case the last method would be the logical one; that is, find the present worth of the estimated net revenue for the next thirty or

* It is interesting to note that the present worth of an annual net revenue for forty and thirty years is about 95 and 90 per cent. respectively of the same sum capitalized at 8 per cent.

FUNDAMENTAL PRINCIPLES OF WATER-WORKS VALUATION

TABLE IV
Valuation Based on "Market Value"

Year	Estimated cost of plant at end of year	Net returns = gross revenue less operating expenses and 1 per cent. depreciation	Net return on \$204,000, original plant cost	Present worth of these net returns on original plant cost at 8 per cent.
1917	\$204,000	\$20,730	\$20,730	\$19,180
1918	204,000	21,560	21,560	18,470
1919	207,300	22,390	22,030	17,490
1920	213,400	23,220	22,190	16,300
1921	219,500	24,050	22,350	15,220
1922	225,600	24,880	22,500	14,180
1923	231,700	25,710	22,640	13,220
1924	237,800	26,540	22,770	12,300
1925	243,900	27,370	22,890	11,450
1926	250,000	28,200	23,010	10,660
1927	256,100	29,030	23,130	9,920
1928	262,200	29,860	23,230	9,220
1929	268,300	30,690	23,330	8,580
1930	274,400	31,520	23,430	7,980
1931	280,500	32,350	23,530	7,420
1932	286,500	33,180	23,620	6,890
1933	292,700	34,010	23,700	6,410
1934	298,800	34,840	23,790	5,960
1935	304,900	35,670	23,860	5,530
1936	311,000	36,500	23,930	5,130
1937	317,100	37,330	24,010	4,770
1938	323,200	38,160	24,080	4,430
1939	329,300	38,990	24,150	4,110
1940	335,400	39,820	24,220	3,820
1941	341,500	40,650	24,280	3,545
1942	347,600	41,480	24,360	3,290
1943	353,700	42,310	24,420	3,060
1944	359,800	43,140	24,470	2,840
1945	365,900	43,970	24,520	2,630
1946	372,000	44,800	24,570	2,440
1947	378,100	45,630	24,620	2,265
1948	384,200	46,460	24,670	2,105
1949	390,300	47,290	24,720	1,950
1950	396,400	48,120	24,760	1,810
1951	402,500	48,950	24,810	1,680
1952	408,600	49,780	24,860	1,555
1953	414,700	50,610	24,900	1,440
1954	420,800	51,440	24,940	1,340
1955	426,900	52,270	24,990	1,240
1956	433,000	53,100	25,030	1,150
				\$272,980
Less accrued depreciation.....				28,150
Required valuation.....				\$244,830

forty years, and from that deduct the accrued depreciation up to the present time.

The next important case is where it is desired to determine the valuation for the purposes of taxation. The common procedure for appraising properties for public taxation is to take the findings of an assessor elected for a term of years.

The law requires that the assessment shall be the true market value of each property. If a property holder thinks his property is assessed too high or too low, he has the right of appeal to the proper tribunal.

The function of the assessor is of great importance, and he should be a man of good experience and ability, but, as the salary is generally meagre and the method of election not such as to insure appointment of the best man for the place, the assessed values are often notoriously unjust. If the assessor happens to be honest and of good judgment, he endeavors to determine what each property would bring in the market if it were put up for public sale with reasonable publicity, and that is the figure

he uses for his assessment. The case is not so difficult as it seems, because there are in his district hundreds of properties of nearly the same kind and many records of private and public sales. But for the case of a public utility, such as a water works, there is only one property like it, and there is usually no means of knowing what it would bring as a whole if put up at public sale. In some cases there may be records of sales of blocks of stocks or bonds, but even these are rarely sufficient to warrant a reliable conclusion as to the market value of the entire property, and therefore, in most cases, the only way to arrive at its market value is to determine the elements upon which market value must depend. Hence we are led by reason to the use of the third method of valuation.

In the court and commission rulings it is plain that they recognize various aspects of valuation, but apparently wish to establish such a valuation as will apply in all cases. So when the term "fair value" was read into one of the most classic of these cases the court evidently considered the matter settled for all time. But "fair value" changes every time the condition or purpose changes, and what applies in one case will not apply in another. So there is no logical justification in working out the valuation according to three fundamentally different principles, and taking some function of the three for the desired result, altho that is apparently what the tribunal means when it substantially says: "Neither the cost of reproduction, the historical cost, nor the capitalized value of the net revenue can be taken as representing the desired valuation, but each has a material bearing and must be considered."

SUMMARIZING

There are three fundamentally different methods of valuation, only one of which is applicable in any particular case.

First method is the legitimate actual cost, including deficiencies of net income below a fair return on the legitimate investment. This is applicable to the fixing of rates and condemnation of the plant by the municipality.

Second method is the estimated cost of reproduction less depreciation plus the value of the revenue ("going value"). This is applicable to negotiations between the city and the water company, whereby the city desires to know what it can afford to pay for the water company rather than build its own works.

Third method is the "market value," determined from a sufficient number of public sales of stocks and bonds, or, if such records are inadequate, the determination of the present worth of the annual gross revenue less the annual operating expenses, less the annual depreciation for the next thirty or forty years. From the sum of these present worths deduct the accrued depreciation of the plant up to the present time. This is applicable to the following cases: Where the rates are fixed for a long and indefinite period in the future, the city has neither right to condemn, build its own works, nor grant a franchise to another water company, and the city or another concern desires to purchase. It is also applicable when it is desired

to create a mortgage or capital stock issue, or to determine the valuation for the purpose of taxation.

The foregoing are illustrations of these three methods of valuation for exactly the same water works system.

The valuation by the first method is.. \$241,107

The valuation by the second method is. 276,744

The valuation by the third method is.. 244,830

Of course, this does not prove that the valuation is always greater by the second method, or that the first and last methods give substantially the same results, but simply shows that there is no necessary relation or agreement of the results.

The foregoing discussion in all cases relates to valuations for going concerns. When we consider the third method, which refers to market value, it is possible in some cases the plant may have a higher value as a salvage than as a going concern. For instance, the water rights, the mineral rights, the land or other natural resources may sell for more as such than the estimated value as a going concern, so, therefore, it is necessary to consider, first, the value as a going concern, and, second, the value for some or any other purpose, and take the higher of these two figures as the real market value; or in some cases it may be obviously better and more economical to sell the land or natural resources and establish new and cheaper sites that will just as satisfactorily answer the purposes of the going concern.

Now, while the foregoing is intended to briefly outline the writer's views on the fundamental principles of water-works valuation from a rational standpoint, it is not contended that the valuation engineer would invariably follow the scheme outlined.

No matter how defective, the laws of the land must prevail and be obeyed, and, while it is the duty of the engineer to exert his efforts toward the establishment of just laws, he must in any particular case act in accordance with the laws at that time existing. Therefore, if the law prescribes that the valuation of a water-works system for rate-making purposes shall be determined by consideration of the past cost, the cost of reproduction of the going concern, and its market value without further amplification, then he must by such process as he believes most suitable determine these three valuations and either supply such weights to each as his judgment dictates or leave the establishment of these weights to the tribunal. The former course will likely be more satisfactory, for the reason that the opinion of a valuation engineer of sufficient experience and judgment to furnish for these three elements of valuation figures that merit the confidence of the tribunal should receive equal respect as to their relative weights.

In the case under consideration, if we say the weights are, estimated,

Past cost 50 per cent.

Reproduction 25 per cent.

Market value 25 per cent.

we obtain:

\$241,107 at 50 per cent.....\$120,553

276,744 at 25 per cent..... 69,186

244,830 at 25 per cent..... 61,208

Resulting valuation.....\$250,947

Heretofore we have been considering "valuation" as applied to the water-works system as a whole. When divisional parts are taken separately we cannot always apply the three processes of valuation described.

In this respect there are two phases which give the appraiser the greatest difficulty: valuation of the water supply, and the valuation of a portion of the system, generally defined as "severance value." Naturally both of these difficulties do not occur in "historical cost," or investment, nor in "estimated cost of reproduction." But they do apply to any consideration of "market value."

WATER SUPPLY VALUATION

Where the water supply is one of several similar properties that are being bought and sold sufficiently often to establish a fair measure of value, there is no better means known for ascertaining the amount, but frequently, if not generally, the water company owns the only supply of proper quality and quantity that can be obtained at equivalent cost, and it has probably never changed hands for water-supply purposes but once, and that was before its value had been recognized for that particular use. It may have cost a minute part of what it is worth to the company. Under these circumstances, how is it to be valued? By taking an extreme case the real nature of the problem will be at once apparent. Suppose an individual buys a tract of land on which is located a flowing spring. By chance a member of his family having diabetes begins to drink freely of the water and is at once relieved and soon cured. A company is formed to bottle and sell the water, which effects other cures. The water then becomes celebrated, and the company is able to sell the water by wholesale and obtain a net revenue of thousands of dollars per year. The value of the spring is now measured by what it will net the company. That is no imaginary case, but substantially the history of the famous White Rock and Bethesda waters at Waukesha, Wisconsin. The cures may have been due to other sources than the specific virtues of these waters, but the ability to sell the waters at high net returns was real and not imaginary. Therefore the value was real and not "intangible." On a comparative scale, the value of any water-works supply is just as real, and depends upon what the water company can obtain in net revenue by selling it to the public. If it were generally known that the Waukesha water could be duplicated at a dozen other places at a small cost for

(Concluded on Page 494)

THE PENNSYLVANIA ELECTRIC CODE

JOHN PRICE JACKSON

PENNSYLVANIA COMMISSIONER OF LABOR AND INDUSTRY AND CHAIRMAN OF THE INDUSTRIAL BOARD

WHEN the Pennsylvania Department of Labor and Industry was created, in 1913, it was discovered that there was no established and uniform practice with regard to safety in most of the industries, and therefore both good and bad methods were being applied with the best intentions. The State inspectors were guided by no directive, established practice, and, as a result, the variations in their work caused more or less confusion. Thus, the requirements in the northwestern part of the State might be quite different from those in the southeastern part of the State. To rectify this most undesirable condition of affairs, in the line of activity having to do with reducing the number and severity of injuries in the State—amounting to one-quarter million injuries and deaths per year—the Industrial Board, a division of the Department of Labor and Industry, determined to prepare a series of safety codes.

After carefully studying the situation as to how codes could best be developed, covering important items regarding safety in construction and operation of the great variety of Pennsylvania's industries, it was decided that the only way to accomplish practical and useful results would be to call in the best experts of the State for voluntary advice and direction. From that time, committees of such experts have been periodically formed to work out safety standards and methods for various industries and processes. Up to the present time hundreds—including possibly some of the readers of this statement—of our most competent and prominent engineers and industrial leaders have freely and generously given of both their time and money to aid the State in this way.

The preparation of an electric code for Pennsylvania was given much time and attention by a large committee composed of many of the leading Pennsylvania electrical engineers and others prominent in the electrical industry. Their work was reviewed and approved by one of the committees delegated for the purpose by the American Institute of Electrical Engineers. Before this code was adopted, however, it was found that the National Bureau of Standards was also preparing an electrical safety code. In order, therefore, to preserve uniformity in standards thruout the United States, the Industrial Board decided to join with the National Bureau of Standards, making available such information as it had gathered. The hearty coöperation on the part of the Pennsylvania committee and the associated Pennsylvania officials enabled the

Bureau of Standards to complete its work. As soon as this was done the Department of Labor and Industry, thru the Industrial Board, at once adopted the code as a standard for this Commonwealth.

This code is quite extensive and in many parts would be drastic if immediate compulsory compliances were required with regard to work already in place or constructed. On the other hand, for new work it is in line with safe practice and should not cause undue difficulty or expense, except in unusual cases. In the case of old work, a careful reading of the code shows that provision is made against any drastic changes that would be unreasonable.

The policy of the Department of Labor and Industry is, in every case, to apply the rule of reason and not work unnecessary hardship. With this object in view, explanation is made at the beginning of the code that where any features of it are impracticable and unreasonable in specific codes application may be made to the Industrial Board and such modification as the conditions warrant will be promptly made. Such a policy has existed in the enforcement of the many other codes and rulings previously developed by the Industrial Board, with the result that but little unnecessary hardship or difficulty has been encountered. In view of past experience and the attitude of the Department, it is confidently felt that the electrical profession of the Commonwealth of Pennsylvania is entirely safe in resting easy that no injustice of unreasonable hardship will be forced upon it, and that where special cases need special consideration they will be given quick and efficient attention. On the other hand, this code has engrossed much of the time and attention of many of Pennsylvania's leading electrical engineers and many others over the entire country, and represents their best thought upon the subject of electrical safety, and will, if accepted fully, be of material benefit to the Commonwealth. It is therefore earnestly urged that those associated with the electrical utilizations or productions in Pennsylvania coöperate heartily and earnestly with the Department in establishing the code as the actual as well as the published practice and standard in this State, and also coöperate with the Industrial Board to eradicate from the code any unnecessary or undesirable features and to make such changes as will improve its efficiency.

ELECTRIC CODE*

ADOPTED BY THE INDUSTRIAL BOARD
PENNSYLVANIA DEPARTMENT OF LABOR AND INDUSTRY
OPERATIVE ON AND AFTER JULY 1, 1917

DEFINITIONS OF SPECIAL TERMS

THE following definitions give the meanings of some of the terms occurring in these rules. Terms not defined will be understood to have their usual meanings.

1. *Electrical supply equipment* means equipment which produces, modifies, regulates, controls, or safeguards a supply of electrical energy. Similar equipment, however, is not included where used in connection with signaling systems under the following conditions:

(a) Where the voltage does not exceed 150.

(b) Where the voltage is between 150 and 400 and the power transmitted does not exceed 3 kilowatts.

2. *Electrical supply station* means any building, room, or separate space within which is located electrical supply equipment and which is accessible as a rule only to properly qualified persons.

This includes generating stations and substations and generator, storage battery, and transformer rooms, but excludes manholes and isolated transformer vaults on private premises. (See definition 46.)

3. *Electrical supply lines* means those conductors and their necessary supporting or containing structures which are located entirely outside of buildings and are used for transmitting a supply of electrical energy.

Does not include open wiring on buildings in yards or similar locations where spans are less than 20 feet, and all the precautions required for stations or utilization equipment, as the case may be, are observed.

Railway signal lines above 400 volts to ground are always supply lines within the meaning of these rules, and below 400 volts may be considered as supply lines, if so run and operated thruout.

4. *Signal lines* means lines for public or private signal or communication service and devoted exclusively to the transmission of signals or intelligence, which operate at not exceeding 400 volts to ground or 750 volts between any two points of the circuit, and the transmitted power of which does not exceed 150 watts. Below 150 volts no limit is placed on the capacity of the system.

Telephone, telegraph, messenger-call, clock, fire, or police alarm, and other systems conforming with the above are included.

Lines used for signaling purposes, but not included under the above definition, are con-

sidered as supply lines of the same voltage and are to be so run.

Signal lines not for public use coming under the above definition may be run and operated as supply lines if desired, and if constantly so run.

5. *Utilization equipment* means equipment, devices, and connected wiring, which utilize electrical energy for mechanical, chemical, heating, lighting, testing, or similar purposes and are not a part of supply equipment, supply lines, or signal lines.

6. *Voltage or volts* means the highest effective voltage between the conductors of the circuit concerned, except that in grounded multiwire circuits, not exceeding 750 volts; between outer conductors, it means the highest effective voltage between any wire of the circuit and the ground.

In ungrounded, low-voltage circuits, voltage to ground means the voltage of the circuit.

When one circuit is directly connected to another circuit of higher voltage (as in the case of an autotransformer), both are considered as of the higher voltage, unless the circuit of lower voltage is permanently grounded. Direct connection implies electrical connection as distinguished from connection merely through electromagnetic or electrostatic induction.

7. *Circuit* means a conductor or system of conductors thru which an electric current is designed to flow, and connected equipment.

8. *Grounded* means connected to earth or to some extended conducting body which serves instead of the earth, whether the connection is intentional or accidental.

9. *Grounded system* means a system having a permanent and effective electrical connection to earth. This ground connection may be at one or more points.

"Effective," as herein used, means a connection to earth of sufficiently low resistance and high current-carrying capacity to prevent any current in the ground wire from causing a harmful voltage to exist between the grounded conductors and neighboring exposed conducting surfaces which are in good contact with the earth, or with neighboring surfaces of the earth itself, under the most severe conditions which are liable to arise in practice.

10. *Permanently grounded* means such an effective connection to the earth (by use of an underground system of metallic pipe mains or other suitable means), as described in the preceding paragraph.

* NOTE.—Printed by courtesy of John Price Jackson, Chairman, Industrial Board.

11. *Current-carrying part* means a part intended to be connected in an electric circuit to a source of voltage. Noncurrent-carrying parts are those not intended to be so connected.

12. *Alive or live* means electrically connected to a source of potential difference, or electrically charged so as to have a potential different from that of the earth. The term "live" is sometimes used in place of the term "current-carrying," where the intent is clear, to avoid repetitions of the longer term.

13. *Dead* means free from any electrical connection to a source of potential difference and from electrical charge; not having a potential different from that of the earth. The term is used only with reference to current-carrying parts which are sometimes alive.

14. *Manual* means operated by personal intervention.

15. *Automatic* means self-acting, operating by its own mechanism when actuated by some impersonal influence; as, for example, a change in current strength. Not manual, without personal intervention. Remote control that requires personal intervention is not automatic, but manual.

16. *Cut-out* means any device, such as a fuse or circuit-breaker, by which the electrical continuity of a conductor may be automatically broken by changes in current or voltage.

17. *Switch* means a device for opening or closing or changing the connection of a circuit manually. In these rules a switch will always be understood to be manually operated, unless otherwise stated.

18. *Disconnecter* means a switch which is intended to open a circuit only after the load has been thrown off by some other means.

Manual switches designed for opening loaded circuits are usually installed in circuit with disconnectors, to provide a safe means for opening the circuit under load.

19. *Substantial* means so constructed and arranged as to be of adequate strength and durability for the service to be performed under the prevailing conditions.

20. *Qualified or authorized* means properly qualified or authorized to perform specified duties under the conditions existing. Responsibility for the authorization and decision as to the qualifications of employees rests with the employer or his agent.

21. *Guarded* means covered, shielded, fenced, inclosed, or otherwise protected, by means of suitable covers or casings, barrier rails or screens, mats, or platforms, to remove the liability of dangerous contact or approach by persons or objects to a point of danger.

22. *Isolated* means that an object is not readily accessible to persons unless special means for access are used.

23. *Isolation by elevation* means elevated sufficiently so that persons may safely walk underneath.

24. *Exposed* means that an object or device can be inadvertently touched or approached nearer than a safe

distance by any person. Objects not suitably guarded or isolated.

25. *Insulated* means separated from other conducting surfaces by a dielectric substance or air space permanently offering a high resistance to the passage of current and to disruptive discharge through the substance or space.

When any object is said to be insulated, it is understood to be insulated in suitable manner for the conditions to which it is subjected. Otherwise, it is, within the purpose of these rules, uninsulated. Insulating covering of conductors is one means of making the conductors insulated.

26. *Insulating* (where applied to the covering of a conductor or to clothing, guards, rods, and other safety devices) means that a device, when interposed between a person and current-carrying parts, protects the person making use of it against electric shock from the current-carrying parts with which the device is intended to be used; the opposite of conducting.

27. *Explosion proof* (in locations where the presence of inflammable gas makes the atmosphere explosive in character) means that an inclosure will withstand, without injury and without transmitting flame to the outside, any explosion of gas which may occur in the inclosures.

28. *Inclosed* (in locations where inflammable flyings, inflammable dust or explosives are present in dangerous quantities) means that an inclosure will not admit accumulations of flyings or dust, nor transmit sparks or flying particles to the accumulations outside.

29. *Conductor* means a metallic conducting material, usually in the form of a wire or cable, suitable for carrying an electric current. Does not include bus bars.

30. *Line conductor* means one of the wires or cables carrying electric current, supported by poles, towers, or other structures, but not including vertical or lateral connecting wires.

31. *Open lines* means overhead lines not in conduits, and consisting of single conductors or of individually twisted pairs, as opposed to multiple conductor cables.

32. *Service* means the connecting conductors by which a supply of electrical energy is carried from a supply line to the building or premises served.

33. *Lateral conductor* means in pole wiring work, a wire or cable extending in a general horizontal direction approximately at right angles to the general direction of the line conductors.

34. *Vertical conductor* means in pole wiring work, a wire or cable extending in approximately vertical direction.

35. *Normal sag* means the difference in elevation between the highest point of support of a span and the lowest point of the conductor in the span (or in the curve of the conductor in the span produced), at 60° F., with no wind loading.

36. *Apparent sag or span* means the departure of the wire in a given span from the straight line between the two points of support of the span, at 60° F., with no wind

loading. Where the two supports are at the same level this will be the normal sag.

37. *Apparent sag* at any point means the departure of the wire at the particular point in the span from the straight line between the two points of support of the span, at 60° F., with no wind loading.

38. *Pole face* means that side of a pole on which cross-arms are attached, or which is so designated by the utilities owning or operating the pole.

39. *Climbing space* means the vertical space reserved along the side of a pole structure to permit ready access for linemen to equipment and lines located on the pole structure.

40. *Lateral working space* means the space reserved for working between conductor levels outside the climbing space, and to its right and left.

41. *Conflicting or in conflict* (as applied to a pole line) means that the line is so situated with respect to a second line (except at crossings) that the overturning of the first line will result in contact between its poles or conductors and the conductors of the second line, assuming that no conductors are broken in either line: *Provided, however,* That lines on opposite sides of a highway, street or alley are not considered as conflicting if separated by a distance not less than 60 per cent. of the height of the taller pole line, but in no case less than 20 feet.

42. *Duct* means (in underground work) a single tubular runway for underground cables.

43. *Conduit* means (in underground work) a group of any number of ducts for underground cables.

44. *Manhole* (more accurately termed *splicing chamber* or *cable vault*) means an opening in an underground system which workmen or others may enter for the purpose of installing cables, transformers, junction boxes, and other devices, and for making connections and tests.

45. *Handhole* means an opening in an underground system into which workmen reach but do not enter.

46. *Transformer vault* means an isolated, fireproof inclosure, either above or below ground, in which transformers, and the devices necessary for their operation, are installed, and which is not continuously under attendance during operation.

47. *Reconstructions* means replacement of any portion of an existing installation by new equipment or construction. Does not include ordinary maintenance replacements.

48. *Urban districts* means thickly settled communities (whether in cities or suburbs) where congested traffic often occurs. A highway, even though in the country, on which the traffic is often very heavy, is considered as urban.

49. *Rural districts* means all places not urban, usually in the country, but in some cases within city limits.

50. *Wire gages*: The American Wire Gage (A. W. G.), otherwise known as Brown & Sharpe (B. & S.), is the standard gage for copper, aluminum, and other con-

ductors, excepting steel, for which the Steel Wire Gage (Stl. W. G.) is used thruout these rules.

51. *Switchboard* means a large single panel or assembly of panels on which are mounted (partly on the face and partly on the back) switches, fuses, busses and usually instruments, and accessible both in front and in rear. Circuits and machinery of relatively large capacity are controlled from such boards.

52. *Panel board* means a single panel containing busses, fuses, and switches to control lights, fan motors, and similar devices of small individual as well as aggregate capacity, placed in or against a wall or partition and accessible only from the front.

53. *Tags* means "*men at work*" tags of distinctive appearance, indicating that the equipment or lines so marked are being worked on.

RULES COVERING METHOD FOR PROTECTIVE GROUNDING OF CIRCUITS, EQUIPMENT AND LIGHTNING ARRESTERS FOR STATIONS, LINES AND UTILIZATION EQUIPMENT

90. Scope of the Rules

The following rules apply to all lightning arrester grounding and to the grounding of all circuits, equipment, or wire runways when the grounding is intended to be a permanent and effective protective measure. These rules do not require that grounding shall be done, but cover the methods for protective grounding. The rules requiring grounding, in accordance with the methods specified below, are included under parts 1, 3, and 4 of the National Electrical Safety Code.

Other methods of construction and installation than those specified in the rules may be used as experiments to obtain information, if done where supervision can be given by the proper administrative authority.

The following rules do not apply to the grounding of arresters on signal circuits, to the grounded return of trolley or third-rail systems, nor to the grounding of lightning protection wires where these are not connected to electrical circuits or equipment.

91. Application of the Rules and Exemptions

(a) The rules are intended to apply to all such installations, except as modified or waived by the proper administrative authority or its authorized agents, and are intended to be so modified or waived in particular cases whenever any rules are shown to involve expense not justified by the protection secured, or for any other reason to be impracticable, or whenever it is shown that equivalent or safer construction can be more readily provided in other ways.

(b) The intent of the rules will be realized (1) by applying the rules in full to all new installations, reconstructions, and extensions, except where any rule is shown to be impracticable for special reasons, or where the advantage of uniformity with existing construction is greater than the advantage of construction in compliance with the rules; (2) by placing grounds on existing

installations or bringing present grounds into compliance with the rules, except where the expense involved is not justifiable.

The time allowed for bringing existing installations into compliance with the rules will be determined by the proper administrative authority.

(c) It will sometimes be necessary to modify or waive certain of the rules in cases of temporary installations or installations which are shortly to be dismantled or reconstructed.

(d) In cases of emergency or pending decision of the administrator the person responsible for the installation may decide as to modification or waiver of any rule, subject to review by proper authority.

92. Where Ground Conductor Shall be Attached (when Grounding is Required by this Code, or is Installed as a Protective Measure, see rule 304)

(a) *Direct Current Distribution Systems.*—The neutral of three-wire direct-current systems shall be grounded at one or more supply stations, but not at individual services nor within buildings served. One side of a two-wire direct-current system may be grounded, but at one station only.

In three-wire systems the neutrals entering any junction box should be bonded together, but the box should not be specially grounded. In two-wire systems the grounded side of the circuit should be insulated from ground except at the station ground connection.

(b) *Alternating Current Distribution Systems.*—All secondary distribution systems shall be grounded at the building services or near the transformer (or transformers) either by direct ground connection (through water-piping system or artificial ground), see rule 94, or by the use of a system ground wire to which are connected the grounded conductors of many secondary mains and which is itself effectually grounded at intervals that will fulfill, for any secondary utilizing the system ground wire, the resistance and current-carrying requirements of rule 96a.

Single-phase, three-wire distribution systems shall be grounded at the neutral conductor. Two-wire, single-phase systems shall be grounded at the neutral point or on either conductor. Two-wire, single-phase and two- or three-phase systems shall, in general, be grounded at that point of the system which brings about the lowest voltage from ground of unguarded current-carrying parts of connected devices and also permits most convenient grounding.

Where one phase of a two- or three-phase system is used for lighting, that phase should be grounded and at the neutral conductor, if one is used.

In the absence of direct grounds at all building services, ground connections shall be made to the grounded neutral or other grounded conductor of a secondary system supplying more than one utilization equipment, at

intervals that will fulfill the resistance and current-carrying requirements of rule 96a.

Where the secondaries of transformers are supplying a common set of mains the fuses shall be installed only at such points as will not cause the loss of the ground connections after the fuses in the transformer circuits or mains have been blown.

Multiple grounds are preferable in all cases, because of the assurance provided against loss of the protection afforded by the chance disconnection of any ground connection.

Grounds other than the single ground connection at the building service shall not be made to alternating-current secondaries within buildings.

(c) *Lightning Arresters.*—The connection to a lightning arrester shall be at such a point that its ground conductor is as short and straight as practicable.

Ground conductors for lightning arresters should not pass thru iron or steel conduits unless electrically connected to both ends of such conduits.

(d) *Equipment and Wire Runways.*—The point at which the ground conductor is attached to equipment or wire runways shall, if practicable, be readily accessible.

93. Ground Conductor

(a) *Material and Continuity.*—The ground conductor shall be of copper or of other metal which will not corrode excessively under the existing conditions and, if practicable, should be continuous. Joints shall be so made and maintained as to conform to the resistance and current-carrying capacity requirements of rule 96.

Ground connections from circuits should not be made to jointed piping within buildings, except that water piping outside of meters and beyond any point which is liable to disconnection may be used. (See rules 94a, 95a, and 95b.)

No automatic cut-out shall be inserted in the ground conductor or connection except in a ground connection from equipment where its operation will immediately result in the automatic disconnection from all sources of energy of the equipment so grounded; no switch shall be so inserted except in plain sight, provided with distinctive marking and effectively isolated from unqualified persons. See also rule 92b, par. 4.

(b) *Size and Number.*—For grounding circuits the ground conductors shall have a combined cross section (and current capacity) sufficient to insure the continuity of the ground connection and its continued compliance with rule 96a, under conditions of excess current caused by accidental grounding of any normally ungrounded conductor of the circuit. No individual ground conductor for electrical circuits shall have less current capacity than that of a No. 6 copper wire, except that for additional grounds after the first on any circuit, smaller ground wires may be used, provided that they are in no case smaller than the conductor to which they are attached nor smaller than No. 10 copper.

For lightning-arrester ground connections the ground conductor or conductors shall have a current-carrying capacity sufficient to insure continuity of the ground connection under conditions of excess current caused by or following discharge of the arrester. No individual ground conductor shall be smaller than a No. 6 wire.

For electrical equipment the current-carrying capacity of a ground conductor shall be not less than that provided by a copper wire of the size indicated in the following table. When there is no cut-out protecting the equipment, the size of ground conductor will be determined by the design and operating conditions of the circuit.

Capacity of nearest automatic cut-outs.	Required size ground conductor, A. W. G.
300 to 500 ampères	4
100 to 200 ampères	6
30 to 100 ampères	10
10 to 30 ampères	14

In portable cord to portable equipment protected by fuses not greater than 10-ampère capacity a No. 18 ground wire may be used.

(c) *Mechanical Protection and Guarding Against Contact.*—Where exposed to mechanical injury the ground conductor shall be protected by substantial conduit or other guard. Guards for lightning-arresters ground conductors should be of nonmagnetic material unless the ground conductor is electrically connected to both ends of the guard.

If the resistance of the ground connection is in excess of the values in rule 96, for water pipe grounds, the ground conductor, except in rural districts, shall be protected and guarded by being inclosed in insulating conduit or molding to protect persons from injury by coming into contact with it.

Such a high resistance may exist where artificial grounds are necessarily permitted in lieu of the preferable grounds to buried metallic water-piping systems.

Mechanical protection and insulating guards should extend for a distance of not less than 8 feet above any ground, platform, or floor from which ground conductors are accessible to the public. (See also rule 246.)

Insulating mechanical protection is advisable for single arrester grounds, even when the connection is made to a water-piping system, and has therefore a low resistance, since a single connection is liable to be accidentally broken.

Even where ground connections have a resistance not exceeding that specified in rule 96 and no guard is therefore provided (or as an additional protection to persons even where guards are used) artificial grounds may be arranged to minimize the potential gradient along the surface of the earth by use of radial connecting wires underneath the earth surface or by other suitable means.

A circuit ground conductor shall be guarded as required for current-carrying conductors of the circuit,

unless the ground conductor is entirely outside buildings, has strength and current capacity not less than that of No. 6 copper wire, and the circuit is elsewhere grounded by other ground conductors; except that in stations substantial bare ground busses may be used.

(d) *Underground.*—Wires used for ground conductors, if laid underground, shall, unless otherwise mechanically protected, be laid slack to prevent their being readily broken, and shall have joints carefully painted or otherwise protected against corrosion.

94. Nature of Ground Connection

The ground connection shall be permanent and effective and be made as indicated in (a), (b), (c), or (d) below; always as in (a), if (a) is available (except as per rule 97b).

(a) *Piping Systems.*—For circuits, equipment, and arresters at supply stations, connections shall be made to all available active continuous metallic underground water-piping systems between which no appreciable difference of potential normally exists, and to one such system if appreciable differences of potential do exist between them. At other places connections shall be made to at least one such system, if available. Gas piping should not be used. (See 93a, 95a, and 95b).

“Available” in this rule means ordinarily within 500 feet for stations.

The protective grounding of electrical circuits and equipment to water-pipe systems in accordance with these rules should always be permitted, since such grounding offers the most efficient protection to life and property and is not injurious to the piping systems.

(b) *Alternate Methods.*—Where underground metallic piping systems are not available, other methods which will secure the desired permanence and conductance may be permitted. In many cases metal well-casings, local metal drain-pipes, and similar buried metal structures of considerable extent will be available and may be used in lieu of extended buried water-piping systems.

In some cases ground connection may be made to the steel frame of a building containing the grounded circuits or equipment, to which frames of machines and other noncurrent-carrying surfaces should also then be connected. In such cases the building frame should be itself well grounded by effective connection to the ground. This may require artificial grounding for steel frame buildings supported on masonry or concrete (unreinforced) footings.

(c) *Artificial Grounds.*—When resort must be had to artificial grounds, their number should be determined by the following requirements:

(1) Not more than one such ground is required for lightning arresters, except where for large current capacity. At least two grounds are required for low voltage alternating current distribution circuits at transformers or elsewhere.

(2) Where no part of the circuit or equipment protected can be reached by persons while they are standing on the ground or damp floors, or by persons while touching any metallic piping to which the ground wire is not effectively connected, a single artificial ground may be used even if its resistance exceeds that specified in rule 96. In such cases it is desirable to provide guards for the ground conductor in accordance with rule 93c wherever it is otherwise accessible, or to provide insulating mats or platforms so located that persons cannot readily touch the ground conductor without standing on such mats or platforms.

(d) *Grounds to Railway Returns.*—Protective ground connections should not be made to railway negative return circuits when other effective means of grounding are available, except ground connections from electric railway lightning arresters.

When ground connections are of necessity made to the grounded track return of electric railways, they shall be made in such a manner as not to afford a metallic connection (as indirectly through a ground neutral with multiple ground) between the railway return and other grounded conducting bodies (such as buried piping and cable sheaths).

This rule does not prohibit the making of drainage connections (which are not protective grounds) between piping systems and railway negative return circuits for the prevention of electrolysis.

Multiple protective ground connections from other circuits to railway returns should be avoided, and where multiple artificial grounds are made on such other circuits near such railway returns, they should be so arranged as to prevent the flow of any considerable current in and between such connections, thus reducing their effectiveness, or causing other damage.

95. Method.

(a) Ground connections to metallic piping systems should be made (except as permitted in *b*) on the street side of water meters, which might interrupt the continuity of the underground metallic-pipe systems, but connections may be made immediately inside building walls to secure accessibility for inspection and test. When water meters are located outside buildings or in concrete pits within buildings where piping connections are imbedded in concrete flooring, the ground connection may be made on the building side of the meters, if they are suitably shunted.

(b) When the making of a ground to a piping system outside meter or other device would involve a long run, connection for equipment or wire runways (but not for circuits) may be made to the water-piping system at a point near the part to be protected, provided there are no insulating joints in the pipe to prevent a good ground.

In such cases care should be taken to electrically connect all parts of the piping system liable to create a hazard (if they become alive) and to shunt the pipe system where necessary around meters, etc., in order to keep the connection with the under-ground piping system continuous.

Gas-piping systems within buildings should not be used for purposes of this rule, except that gas piping need not be insulated from otherwise well-grounded electrical fixtures and where the making of another ground connection for a fixture would involve a long run and the fixture is therefore, of course, not within reach of plumbing or plumbing fixtures, the gas piping may for small fixtures be utilized as the sole ground connection. Where so used the gas-piping and water-piping systems within the building shall be grounded at their points of entrance. (See rule 93a and 94a.)

(c) The ground connection to metallic piping systems should be made by sweating the ground wire into a lug attached to an approved clamp and firmly bolting the clamp to the pipe, after all rust and scale have been removed, or by soldering the ground connection into a brass plug which has been tightly screwed into a pipe fitting or, where the pipe is of sufficient thickness, screwed into a hole in the pipe itself, or connection may be made by other equivalent means. The point of connection should be as readily accessible as possible, and the position should be recorded.

With bell and spigot joint pipe it may be necessary to connect to several lengths where circuits or equipment of large current-carrying capacity are being grounded.

(d) Artificial grounds should be located, where practicable, below permanent moisture level, or failing this at least 6 feet deep. Each ground should present not less than 2 square feet surface to exterior soil. Areas where ground water level is close to the surface should be used when available.

96. Ground Resistance

(a) *Limits.*—It is recommended that the combined resistance of the ground wires and connections of any grounded circuit, equipment, or lightning arrester should not exceed the values given below, if ground connections made according to rule 94 will sufficiently limit the resistance.

It will frequently be impracticable, with artificial grounds, to obtain resistances in dry or other high resistance soils as low as the values given below for ordinary soils. In such cases use two grounds as defined in rule 95d, and no requirement will be made as to resistance. See also rules 94c-2.

The current stated opposite the different resistances in the table is either the current capacity of a circuit from which leakage can occur to the grounded circuit, or the continuous current capacity to which the grounded equipment or arrester is limited by design or by automatic cut-outs.

Where secondary is exposed only through transformer windings, this current capacity will be that of the primary fuse of the transformer. Where the secondary is exposed by the conductors of conflicting or crossing high-voltage circuits, the current capacities will be those of the automatic cut-outs in such circuits.

Ampères.	Water-pipe grounds.	Artificial grounds, ordinary soils.
	Ohms.	Ohms.
Less than 10	15	25
10 to 25	6	25
25 and above	or less	25

The product of the corresponding numbers in the first and second columns is never greater than 150—that is, the potential difference due to the stated current is never greater than 150 volts—where connections are made to water pipes.

Where more than one ground is made on the same circuit, equipment, or arrester, in the same vicinity, all such grounds are considered collectively in respect to meeting the requirements of this rule.

(b) *Checking*.—The resistance of station grounds should be checked when made. With artificial grounds this check may be made by measuring the voltage between the grounded point of the circuit, or the grounded frame of the equipment or the grounded point of the lightning arrester and an auxiliary metal reference rod or pipe driven into the ground, while a measured current is flowing through the ground connection and any exposed metal piping or other artificial ground in the vicinity, but not within 20 feet.

If the station ground is to water piping, the check may be made with current flowing through the water piping and some independent piping system or artificial ground in the vicinity, but not within 20 feet.

The auxiliary rod or pipe should be at least 10 feet from any artificial ground or piping systems through which the measured current is made to flow.

All ground connections shall be inspected periodically.

Ground connections on distribution circuits should, when installed, be tested for resistance unless multiple grounding to water-piping systems is used.

97. Joint Use of Grounds and Ground Conductors for Different Systems

(a) *Ground Conductors*.—Ground conductors should be run separately to the ground (or to a sufficiently heavy grounding bus or system ground cable which is well connected to ground at more than one place) from equipment and circuits of each of the following classes:

1. Lightning arresters.
2. Secondaries connected to low voltage lighting or power circuits.
3. Secondaries of current and potential transformers and cases of instruments on these secondaries.

4. Frames of direct current railway equipment and of equipment operating in excess of 750 volts.

5. Frames of utilization equipment or wire runways other than covered by item 4.

(b) *Grounds*.—Lightning arrester ground connections shall not be made to the same artificial ground (driven pipes or buried plates) as circuits or equipment, but should be well spaced and, where practicable, at least 20 feet from other artificial grounds.

RULES FOR THE INSTALLATION AND MAINTENANCE OF ELECTRICAL SUPPLY STATIONS AND EQUIPMENT

GENERAL PROTECTIVE REQUIREMENTS

Protective Arrangements of Stations and Sub-Stations

100. Scope of the Rules

The following rules apply to the electrical supply equipment of indoor and outdoor stations and sub-stations. They also apply to similar equipment, including generators, motors, storage batteries, transformers, and lightning arresters when installed in factories, mercantile establishments, vehicles, or elsewhere, provided the equipment is in separate rooms or inclosures, under control of properly qualified persons, if the interiors of such rooms or inclosures are accessible only to such persons.

101. Applications of the Rules and Exemptions

(a) The rules are intended to apply to all such installations, except as modified or waived by the proper administrative authority or its authorized agents and are intended to be so modified or waived in particular cases whenever any rules are shown to involve expense not justified by the protection secured, or for any other reason to be impracticable; or whenever it is shown that equivalent or safer construction can be more readily provided in other ways.

(b) The intent of the rules will be realized (1) by applying the rules in full to all new installations, reconstructions, and extensions, except where any rule is shown to be impracticable for special reasons or where the advantage of uniformity with existing construction is greater than the advantage of construction in compliance with the rules; (2) by placing guards on existing installations or otherwise bringing them into compliance with the rules, except where the expense involved is not justifiable.

The time allowed for bringing existing installations into compliance with the rules will be determined by the proper administrative authority.

(c) It will sometimes be necessary to modify or waive certain of the rules in cases of temporary installations or installations which are shortly to be dismantled or reconstructed.

(d) In cases of emergency or pending decision of the administrator, the person responsible for the installation may decide as to modifications or waiver of any rule, subject to review by proper authority.

102. General Requirements

All rooms or spaces in which electrical supply equipment is installed shall comply with the following requirements:

(a) They shall be used neither for the storage of material nor for manufacturing processes causing hazard to electrical operators, except those materials or processes attendant upon the production or distribution of a supply of electrical energy.

(b) They shall be free from flyings and inflammable gas (excepting battery rooms, see section 13); indoor stations should be dry and well ventilated.

(c) In outdoor stations or stations in wet tunnels or subways all live parts of equipment should be inclosed in weather-proof cases, unless the equipment is suitably designed to withstand the prevailing atmospheric conditions and the live parts are suitably guarded against contact, or isolated by elevation.

Ungrounded conductors not in conduit should be on suitable insulators, properly guarded or isolated by elevation.

103. Illumination

(a) Rooms and spaces shall have good artificial illumination. Arrangement of permanent fixtures and plug receptacles shall be such that portable cords need not be brought into dangerous proximity to live electrical apparatus. All lamps shall be arranged to be controlled, replaced, or trimmed from readily accessible places.

(b) A separate emergency source of illumination, from an independent generator, storage battery, gas main, lanterns (the latter two should never be used in battery rooms), or other suitable source, shall be provided in every station where an attendant is located.

104. Inclosing Walls and Ceilings

(a) Rooms and spaces shall be so arranged with fences, screens, partitions, or walls, as to prevent entrance of unauthorized persons or interference by them with equipment inside, and entrances not under observation of an authorized attendant shall be kept locked. Signs prohibiting entrance to unauthorized persons shall be displayed at entrances.

(b) Above all equipment substantial roofs or ceilings shall be provided, except above equipment placed outdoors, where such portions of the equipment as would be injured by rains or by flying or falling objects are suitably inclosed or guarded to prevent such damage.

105. Floors, Floor Openings, Passageways, Stairs

(a) Floors shall have even surfaces and afford secure footing. Projecting nails, loose boards, uneven or greasy wood floors, and smooth iron floors should be avoided.

(b) Passageways (including stairways) and working spaces shall be unobstructed, and (except such as are used solely for infrequent inspection, construction and repair) shall, where possible, provide at least 6.5 feet headroom. (See rule 114.)

(c) All floor openings over 2 feet deep, and all stairways or raised platforms over 4 feet high shall be provided with suitable handrails.

Except for loading platforms, such rails are recommended where height exceeds 2 feet, especially where they are adjacent to live or moving parts, or the working space on the platform is restricted.

(d) All floor openings over 6 feet deep, and the edges of all raised platforms over 6 feet high, shall, where possible, be provided with suitable toe boards.

(e) Toe boards shall, where possible, be arranged at back of stairway treads where over exposed live or moving parts or over working spaces, passageways, or other stairways.

106. Exits

(a) Each room or space and each working space about equipment shall have suitable means of exit which shall be kept clear of all obstructions.

(b) If the plan of the room or space and the character and arrangement of equipment are such that an accident would be liable to prevent an employe from getting out of the room through a single exit, as in the case of long narrow rooms, platforms or passageways, a second exit shall, if practicable, be provided.

107. Fire Fighting Appliances

Each room or space where an operator is in attendance shall be provided with adequate approved fire-extinguishing appliances conveniently located and conspicuously marked. Any such appliances which have not been approved by Underwriters' Laboratories for use on live parts should be plainly and conspicuously marked with a warning to that effect whenever placed in rooms containing exposed live parts over 300 volts to ground.

*Protective Arrangements of Equipment***110. General Requirement**

All electrical supply equipment shall be of such construction and so installed and maintained as to reduce the life hazard as far as practicable.

111. Inspections

Electrical supply equipment shall comply with these safety rules when placed in service, and shall thereafter be periodically cleaned and inspected. Defective equipment shall be put in good order or permanently disconnected. Defective wiring, when hazardous, shall be repaired or removed.

112. Infrequently Used Equipment

Infrequently used equipment or wiring maintained for future service should be periodically inspected to determine its fitness for service.

113. Protective Grounding

(a) *Grounding Method.*—All lightning arrester grounding, and all grounding of circuits, equipment, or wire runways, which is intended to be a permanent and

effective protective measure, shall be made in accordance with the methods specified in Section 9, Method for Protective Grounding.

(b) *Grounding Noncurrent-Carrying Metal Parts.*—All electrical supply equipment, if operating at over 150 volts to ground, or if in hazardous locations, shall have their exposed noncurrent-carrying metal parts, such as frames of generators, motors, and switchboards, and cases of transformers and oil switches, permanently grounded. (See rules 124*b* and *c*, and 168.)

When for purposes of voltage regulation, generators or convertors supplying circuits not exceeding 150 volts to ground, are operated at not more than 180 volts they are considered as not exceeding 150 volts to ground.

Hazardous locations include those where dampness, acid fumes, explosives, inflammable gas, or flyings normally exist.

(c) *Exceptions.*—Exposed noncurrent-carrying metal parts of electrical supply equipment operating on grounded direct-current circuits or on series direct-current circuits may be left ungrounded where no inflammable gas is present, provided that suitable insulating floors, platforms, or mats are used, so that no person can inadvertently come in contact with such ungrounded parts while he is standing upon any grounded surface (including floors not of insulating material); and also that suitable permanent insulating barrier guards are used so that the person can not, while touching the ungrounded parts, at the same time inadvertently touch other machine frames or metallic fixtures not bonded to the parts in question. This rule, where providing for barrier guards, does not apply to the motor frame of a direct-connected, motor-driven, high-tension, series generator sets in existing installations, where for operating reasons the generators must have their frames insulated from ground, and the motor frames are grounded, if it is impracticable to provide insulating barrier guards in the space available. (See rule 124.)

(d) Where exposed noncurrent-carrying metal parts are not grounded they shall be suitably insulated from the ground, and from neighboring grounded surfaces.

114. Working Space about Electrical Equipment

(a) Adequate working space with secure footing shall be maintained about all electrical supply equipment which requires adjustment or examination during operation. (See rule 15*b*.)

Working spaces about exposed live parts over 300 volts to ground shall be made inaccessible to other than authorized attendants by the use of suitable barriers when necessary.

(b) The spaces shall be so arranged as to give the authorized attendants ready access to all parts requiring attention, and shall, where practicable (except where used only for infrequent construction, inspection, and repair), provide the following minimum working spaces:

(1) If there are exposed live parts from 300 volts up to 750 volts on one side, the minimum width shall be 2.5 feet; above 750 volts, not less than 3 feet.

(2) If there are exposed live parts from 300 volts up to 750 volts on the both sides, the minimum width shall be 3 feet; above 750 volts, not less than 5 feet.

115. Guarding Live Parts

(a) Protection shall be provided for persons near otherwise exposed ungrounded current-carrying parts of electrical supply equipment (such as bus bars and other conductors on the terminals of generators and motors), operating at over 300 volts to ground and not effectively isolated by elevation (except where these parts are away from passageways, and working spaces, used for frequent construction, inspection, and repair), as given below.

(b) Where the working space about electrical equipment is less than that specified in rule 114*b*, 1 and 2, suitable inclosures or barriers shall be provided to prevent inadvertent contact with live parts. If such inclosures must be opened or barriers removed while the parts they guard are alive, all surrounding floors shall be provided with suitable insulating platforms or mats, so placed that the operator cannot readily touch the live parts without standing on the mat or platform.

Inclosures may consist of suitable casings or suitable insulating coverings. The insulating covering of conductors should be depended upon only when it is impracticable to install more suitable guards and then only when very substantial, thoroughly dry, and containing no noninsulating flame-proofing compound or oil-soaked rubber.

Barriers may consist of horizontal or vertical strips placed in front of current-carrying parts, or of closely spaced partitions between such parts, extending beyond the exposed sides of the current-carrying parts.

Where covers, casings, or barriers must at any time be removed while the parts which they guard are alive, they should be of insulating material, or so arranged that they cannot readily be brought in contact with the live parts.

Mats may be of wood, held together by wood pins, or of cork matting, linoleum, or rubber. The material and construction should be suitable for the voltage concerned and for the prevailing conditions. If subject to moisture or to accumulations of conducting dust, flyings, or chips, mats should provide surfaces minimizing the hazards from these sources.

(c) Where the specified working spaces are provided and the current-carrying parts are not guarded by inclosures or barriers the insulating platforms or mats shall always be provided.

(d) Where the current-carrying parts operate at over 7500 volts the inclosing or barrier guards shall always be provided, even where insulating mats are also provided.

Inclosing or barrier guards not of grounded metal should be of substantial material and spaced from the current-carrying parts not less

than three times the needle-point sparking distance, at the voltage concerned, of the intervening air, oil, or other dielectric. This rule does not apply to direct-connected, motor-driven, high-tension, series generators, which for operating reasons must have their frames insulated from ground.

(c) Bare parts at different potentials shall be effectively separated. Such parts in circuits of large capacity or operating at above 7500 volts shall, unless provided with inclosures or other guards specified in (b) above, be provided with suitable barriers, if practicable, so that they will not be short-circuited by tools or other conducting objects.

116. Isolating Live Parts by Elevation (for Switchboards see rule 176c)

Current-carrying parts need not be guarded if they are maintained at the following distances above the floors which may be occupied by persons:

Voltage of conductors.	Elevation in feet.
300 to 750	7.0
750 to 2 500	7.5
2 500 to 7 500	8.0
7 500 to 30 000	9.0
30 000 to 70 000	10.0
70 000 to 100 000	12.0
Over 100 000	14.0

117. Identification

(a) Electrical supply equipment shall be suitably identified when necessary for safety. The identification may be by position, color, number, name plate, label, design, or other means.

(b) The voltage and intended use shall be shown when important.

ROTATING EQUIPMENT, STORAGE BATTERIES, AND TRANSFORMERS

Rotating Equipment

(This includes generators, motors, motor-generators, and converters.)

120. Speed-Control and Stopping Devices

(a) Prime movers driving generating equipment shall be provided with automatic speed-limiting devices (in addition to their governors, if necessary, as with some types of steam turbines) where harmful overspeed can otherwise occur.

(b) Separately excited direct-current motors, series motors, and motor-generators and converters, where it is possible for them to be driven at an excessive speed from the direct-current end by a reversal of current or decrease of load, shall be provided with speed-limiting devices, unless the load and the mechanical connections thereto are of such a character as to safely limit the speed.

(c) Where the speed control of direct current motors is accomplished by varying the field resistance, and the nature of the load and the range of the field rheostat are such as to make a dangerous speed attainable and no

speed-limit devices are used, the field rheostats shall be arranged with no-voltage releases or other devices so that the motor cannot be started or continued in operation under dangerously weakened field, except where a hazard to service or apparatus might result from operation of such a device.

(d) Stopping devices, such as switches or valves which can be operated from locations convenient to machine operators, shall be provided for prime movers or motors driving generating equipment.

(e) Where speed limiting or stopping devices are electrically operated the control circuits by which such devices are actuated shall be in conduit or otherwise suitably protected from mechanical injury.

121. Protecting Shaft Ends, Pulleys, Belts, and Other Moving Parts.

Pulleys, belts, and shaft ends projecting through bearings, revolving armatures, revolving fields, and other moving parts shall either be entirely inclosed in suitable casings or otherwise adequately guarded by rails or barriers where persons would be liable to be injured by those parts.

122. Guards for Live Parts

(a) Suitable insulating mats or platforms of substantial construction and providing good footing shall be so placed on floors and, if necessary, on frames of machines having exposed live parts above 300 volts to ground, that operators cannot readily touch such parts unless standing on the mat or platform.

(b) For parts above 750 volts, suitable inclosing or barrier guards shall, if practicable, be provided (in addition to mats or platforms), so arranged that the operator cannot inadvertently touch at the same time these live parts and any neighboring grounded parts.

(c) Where necessary, steps and handrails shall be installed on or about large machines to afford ready access to live parts which must be examined or adjusted during operation.

(d) Where switches are installed on the frames of generating equipment for the purpose of reducing inductive voltage in generator and convertor field coils they shall be suitably constructed or guarded to prevent passers-by from inadvertently coming in contact with the live parts, to protect persons handling them, and to prevent their being accidentally opened or closed.

(e) Suitable shields or barriers shall be provided where necessary to prevent arcs from large commutators or circuit-breakers from injuring persons in the vicinity as in the case of narrow switchboard galleries or similar working spaces located immediately above or beside such equipment.

123. Hazardous Locations

(a) In locations where explosives, inflammable gas or inflammable flyings normally exist in dangerous quantities all parts at which sparking or arcing are liable to occur shall be so inclosed as to reduce the hazard as far as practicable.

This inclosure shall be by one of the following methods:

(1) By placing in separate compartments or rooms.
(2) By using casings of the inclosed type when inflammable dust or flyings are present.

(3) By using explosion-proof casings when inflammable gases exist in dangerous quantities.

(b) All casings shall be nonabsorptive and noncombustible, and when of metal shall be permanently grounded if within reach of grounded surfaces.

124. Grounding Noncurrent-Carrying Parts

(a) All exposed noncurrent-carrying metal parts of rotating electrical supply equipment shall be permanently grounded in accordance with the requirements for grounding provided in rule 113.

(b) Where machine frames such as those of series arc-light generators or direct-current railway generators are necessarily ungrounded, suitable insulating floors, mats, or platforms providing good footing shall be so placed that no person can readily touch the machine frame unless standing on such floor, mat, or platform.

(c) Where two or more machines, either of which operates at over 150 volts to ground, are mechanically coupled together and the operator can touch the frames of more than one at a time, the frames of all such shall be permanently grounded or bonded together electrically. This rule may be waived with high-voltage series generator sets in existing installations where for operating reasons the generators must have their frames insulated from the ground and the motor frame is grounded, and where it is impracticable to place insulating barriers between the grounded and ungrounded frames.

(d) Exciters and auxiliary circuits electrically connected to generators or other machines over 750 volts to ground (with frames ungrounded) shall be installed, protected, and identified as machines and circuits of the same voltage as that of the machine for which they are auxiliaries. (See also rule 141.)

125. Deteriorating Agencies

(a) Suitable guards or inclosures shall be provided to protect exposed current-carrying parts, insulation of leads, balancing coils, or other electrical devices belonging to motors and generating equipment where installed directly under equipment or in other locations where dripping oil, excessive moisture, steam, vapors, or similar injurious agents exist.

(b) The metal frames and other exposed noncurrent-carrying metal parts of equipment in these locations shall be permanently grounded.

Storage Batteries.

The following rules (except 133) apply only to storage batteries exceeding 50 kilowatt hours capacity at the eight-hour rate of discharge.

130. Isolation

Storage batteries shall be made inaccessible to other than properly qualified persons by being placed in a separate room or inclosure.

131. Ventilation

Rooms or inclosures containing storage batteries shall be so ventilated as to remove acid spray and prevent dangerous accumulation of inflammable gas.

Communication of drafts to other rooms should be prevented.

132. Suitable Supports and Floors

The cells shall be supported by suitable insulators, except small cells of insulating material. Suitable drainage or other means shall be provided beneath cells to prevent the accumulation of electrolyte in case of leakage or spraying.

Acid-resistive floors, such as vitrified brick set in pitch, are recommended where large batteries are installed.

133. Guarding Live Parts in Battery Rooms

(a) The arrangement of cells and connections shall be such that no two current-carrying parts between which a voltage exceeding 150 exists, shall be closer than 3 feet, if the parts are so exposed that persons are liable to make accidental contact with both at the same time.

(b) No conductor above 150 volts to ground shall be placed in any passageway, unless guarded or isolated by elevation.

134. Illumination

Storage-battery rooms should be lighted, if practicable, from outside lamps. If lamps are inside, only incandescent electric lamps in keyless porcelain or composition sockets, controlled from points not exposed to battery vapor, shall be used.

135. Acid-Resisting Coverings

Conductors in battery rooms, if of such material or so located as to be liable to corrosion, shall have suitable protective coverings or coatings, unless the ventilation is such as to render this unnecessary.

Transformers, Reactances, Induction Regulators, Balance Coils, and Similar Equipment

140. Current Transformers Secondary Circuits

(a) Secondary circuits of current transformers, including constant-current and instrument transformers (except those supplying relays only, or those having their primary circuits always disconnected before the secondary circuits are worked on), shall be provided with means of short-circuiting them which can be readily connected while the primary is energized and which are so arranged as to permit the removal of any instrument or other device from such circuits without opening the circuits.

(b) Where primaries are above 7500 volts, secondary circuits, unless otherwise adequately protected from injury or contact of persons, shall be permanently grounded conduit.

141. Grounding Low-Voltage Circuits of Instrument Transformers

The low-voltage circuits of all instrument transformers shall be permanently grounded unless the circuits are installed, guarded, and plainly identified as required for the high-voltage circuits of the transformers.

This will sometimes require marking to distinguish such a low-voltage circuit from others with which it is associated, but which are protected by ground connections.

142. Grounding Transformer Cases

The metal case or exposed frame of each transformer, reactance, and similar equipment, which is located where dampness or inflammable gas normally exists, or which is connected to a circuit operating at over 150 volts to ground, shall be permanently grounded.

Exception is permissible in locations free from inflammable gas, where the entire transformer is isolated or guarded as required for the highest voltage circuit connected with the transformer, and is plainly and conspicuously identified as of that voltage.

143. Transformers

Transformers shall be installed according to one of the following methods:

On poles or (when permitted by local authority) on walls of buildings, in which case they shall comply with overhead-line rules. (See rules 247 and 253.)

In rooms in which other equipment is installed, in which case the construction grounding and guarding for live parts shall comply with the rules covering station construction or utilization equipment, as they may apply in each case.

In transformer vaults or rooms which shall be made inaccessible to unauthorized persons.

Where the amount of oil in transformer casings is considerable and the transformers are located in buildings used for other than station purposes, they should be placed in suitable transformer vaults. (See rule 308.)

***Wiring and Protection and Control Equipment.—
Conductors.*****150. Electrical Protection**

(a) Conductors shall be suitable for the location, use, and voltage. Conductors should be protected against excessive heating by the design of the system or by automatic cut-outs, except grounded conductors, field excitation circuits, circuits supplying interconnected 3-wire systems of underground distribution, and other circuits the opening of which may cause special hazard to life through interruption of service.

Such automatic cut-outs may be set so as to interrupt the circuits only on excessive short circuits, if constant attendance is provided and protection is thus also afforded by manual operation.

(b) Conductors normally grounded for the protection of persons shall be arranged without automatic cut-outs interrupting their continuity between the source of energy and the point at which the ground wire is attached, unless the operation of such a cut-out automatically results in the immediate disconnection of the grounded circuit from all sources of electrical energy.

(c) Conductors shall be provided with one or more suitable switches to effectively disconnect them from all sources of electrical energy.

151. Mechanical and Thermal Protection

(a) Where exposed to mechanical injury suitable casing, armor, or other means shall be employed to prevent injury or disturbance to conductors, their insulation, or supports.

(b) Where conductors with insulating coverings are closely grouped (as sometimes on the rear of switchboards or in cableways) they shall have a substantial flame-proof outer covering.

(c) Large uninsulated conductors liable to be torn from their supports by the stresses to which they are subjected (as by the magnetic fields produced) shall be so supported that they cannot come in contact with the surfaces along which they are run or with other conductors.

152. Isolation by Elevation

All conductors over 750 volts, and ungrounded bare conductors over 300 volts to ground shall be isolated by elevation (as required by rule 116), unless guarded in accordance with rule 153, so that no person can inadvertently come in contact with them; provided that busses and bus structures and line connections thereto, installed in accordance with rules 114 and 169d, in suitable locations specially arranged for such purposes, shall not be required to be so isolated.

153. Guarding Conductors

(a) *Use of Inclosing Casings.*—Where insulated conductors are inclosed, suitable permanently grounded metal conduit or grounded metal sheathing shall be used; or in lieu thereof other ducts, runways, or compartments of tile, bitumenized fiber, concrete, or other suitable fire-resistive materials may be used, if containing no exposed combustible material. In damp places, conduit, ducts, or runways shall be made waterproof and be provided with suitable means for draining off condensation, unless the conductors contained are lead-sheathed cables.

(b) *Conductors Above 750 Volts in Conduit or Sheathing.*—Conductors operating at over 750 volts (unless separately supported and effectively isolated by elevation or by inclosing in suitable compartments or screens, as in paragraph d) shall be suitable metal-sheathed cable, run in metal conduits or suitable fire-resistive ducts or compartments, with the metal sheathing permanently grounded. Other covering may be used in suitable grounded metal conduit or insulating duct, when installed in dry locations. The conduit or duct shall provide a

smooth runway with smooth outlets. Metal conduit, if used, shall be made electrically and mechanically continuous with the metal casings of all conduit fittings.

(c) *Metal-Sheathed Cable Outlets Above 750 Volts.*—The insulation of the several conductors of multiple conductor cable, where leaving the metal sheath at outlets, shall be thoroly protected from mechanical injury, moisture and electrical strains by means of a pot head or equivalent method.

(d) *Open Conductors Above 750 Volts.*—When any open insulated conductor above 750 volts, or any open bare conductor above 300 volts to ground, is necessarily brought closer to the floor line than the clearances required for isolation by elevation, they shall be guarded by permanent screens, by inclosing partitions, or by suitable barrier guards.

(e) Where barrier rails only are used, the surrounding floors shall be provided with suitable insulating platforms, mats, or covers. (See rule 115b.)

154. Guarding in Hazardous Locations

(a) Conductors in locations where inflammable gas normally exists shall be in metal conduit or metal-sheathed cable. All fittings and outlets of such conduit and cable shall be electrically and mechanically continuous with the conduit or metal sheath, and the conduit shall be sealed to prevent entrance of gases.

(b) Conductors in damp locations, if neither in conduit nor in water-proof metal sheaths in other suitable ducts, shall be effectively isolated and supported on a suitable type of insulator.

155. Pendants and Portables

(a) Pendant conductors shall not be installed where they can readily be moved so as to bring them in contact with live parts of electrical supply equipment.

(b) Portable conductors shall be attached to fixed wiring only through separable attachment plugs which will disconnect all poles by one operation. (See Sec. 37.)

156. Temporary Wiring

Temporary wiring which is not in compliance with these rules may be used when it is constantly under competent supervision or protected by suitable barrier guards and warning signs while it or neighboring wiring is alive and accessible to any person.

157. Taping Ends and Joints

Ends and joints of insulated conductors, unless otherwise adequately guarded, shall have equal insulating-covering with other portions of the conductor.

Fuses and Other Cut-Outs; Switches and Controllers

160. Accessible and Indicating

All switches, automatic cut-outs, starting rheostats, and other control devices shall be readily accessible to authorized persons. They shall be so arranged or marked as to identify the equipment controlled by them, and (except fuses) shall indicate whether they are open or closed. They shall be so installed as to minimize the

danger of accidental operation, and where practicable so that gravity cannot close them; such switches as close by gravity shall be provided with a proper latch or stop block to prevent accidental closing. Where practicable, the blades of knife switches should be dead when the switches are open.

161. Hazardous Locations

In locations where explosives, inflammable gas or inflammable flyings normally exist in dangerous quantities, all parts at which sparking or arcing are liable to occur shall, if practicable, be so inclosed as to prevent hazard. (See rule 123.)

162. Where Switches are Required

(a) Suitable switches or cut-outs which may be manually operated shall be inserted in all leads (except a grounded conductor) to generators, motors, transformers (except instrument transformers) and all outgoing supply circuits.

(b) In most cases the switch called for should be capable of opening the circuit under overloads. In some cases as between generators and transformer banks used with them, disconnectors only would be required.

(c) Where two or more pieces of electrical supply equipment or supply lines are operated as a single unit no switch is necessarily required between them.

(d) Switches shall not be required in underground manholes or in transformer vaults except as may be deemed necessary by the utility to meet operating requirements.

163. Switches or Other Grounding Devices

It is recommended that switches or other suitable means be provided, where practicable, to facilitate short-circuiting and grounding equipment or lines for which the operating rules require grounding to protect workmen. (See Section 45-46.)

164. Character of Switches and Disconnectors

(a) *Capacity.*—Switches used otherwise than as disconnectors shall be of suitable voltage and ampère rating for the circuit on which they are installed, and be marked with the current which they can safely interrupt.

Disconnectors shall be of suitable voltage and ampère rating for the circuit on which they are installed, and shall be marked with warning against opening when carrying load. Where a group of disconnectors is contained in one room or compartment a single conspicuous sign may be sufficient.

(b) *Locking.*—Remotely controlled switches, oil switches and disconnectors shall be so arranged that they can be secured or blocked in the open position and plainly tagged to prevent careless closing while work is being done on equipment controlled by them, unless the switches are so constructed or installed as to prevent accidental closing or all live or moving parts of the equipment they control are so guarded as to render blocking and tagging unnecessary.

For switches and disconnectors the accidental opening of which may cause hazard, similar arrangements are desirable for retaining them in closed position.

Locking is recommended rather than blocking wherever parts of equipment are remote from the point of control.

Locking or securing doors of compartments is one means of securing switches in the open position to prevent careless closing while work is being done on the equipment controlled. Blocking the jaws of knife switches is also a common method.

(c) *Air Brake*.—Unless a switch operating on a circuit above 750 volts makes an air-brake it is recommended that there shall be installed between it and the source of energy supply a suitable air- or oil-brake disconnector or equivalent device having an air- or oil-gap suitable for the operating voltage of the circuit. (See rule 437.)

(d) *Alignment*.—Knife switches shall maintain such alignment under service conditions that they can be closed with a single unhesitating motion.

165. Where Automatic Cut-outs are Required

(a) All circuit leads to motors, transformers, or station auxiliaries shall be protected by suitable automatic cut-outs, except as noted in rule 150.

(b) Where two or more pieces of electrical supply equipment or supply lines are operated as a single unit no automatic cut-out is necessarily required between them.

166. Disconnecting of Fusible Cut-outs Before Handling

Fusible cut-outs in circuits operating at over 150 volts to ground shall be arranged in one of the following ways:

(a) The ungrounded current-carrying parts cannot be touched by persons re-fusing the cut-outs until the fuses have been disconnected from all sources of electrical energy.

(b) The cut-out can be disconnected by a suitable switch in series.

(c) The fuse can be conveniently handled by means of insulating handles or portable appliances provided for the purpose.

Fusible cut-outs below 150 volts to ground and less than 60 amperes' capacity are exempted from the provisions of this rule.

167. Arcing or Suddenly Moving Parts

(a) Fuses and circuit-breakers shall, as far as possible, be so located and shielded that persons will not be burned by their operation.

(b) Handles or levers of circuit-breakers and similar parts which may move suddenly, in such a way that persons in the vicinity are liable to be injured by being struck by them, shall be guarded or isolated, where practicable.

168. Grounding Noncurrent-Carrying Metal Parts

Exposed noncurrent-carrying metal parts of switch and fuse cases, levers, and other similar parts to which

leakage is liable to occur from live parts, and thereby create a hazard, shall be permanently grounded according to the provisions of rule 113.

Minor parts, such as ferrules of knife switches, which are not liable to become alive, are excluded.

169. Guarding Live Parts of Switches and Automatic Cut-outs Not Installed on Switchboards

(a) *Above 750 Volts*.—All switches interrupting circuits over 750 volts shall be operated by means of remote control mechanisms or be provided with suitable casings protecting the operator from danger of contact with current-carrying parts, except as provided in (d) below, for switches requiring only infrequent attention and located in inclosures from which even the operator is normally excluded. The control devices for switches shall indicate whether switches are open or closed. Lever-operated, circuit-breaker-type switches should be equipped with indicating devices to show, other than by the position of the handles, whether they are open or closed. All automatic cut-outs not suitably isolated by elevation shall be of an incased type or be provided with suitable inclosures for all current carrying parts.

Large-capacity, high-voltage oil switches should, where practicable, be placed away from the operator and operated by remote (or lever) control, since the blowing up of the oil containers may cause serious injuries to persons in the vicinity.

For the purpose of this rule voltages in excess of 750 will be included as below 750 where the excess is for purposes of regulation only.

(b) *Below 750 Volts*.—All switches interrupting circuits under 750 volts shall be operated by means of remote-control mechanisms or be incased during ordinary operation or be provided with insulating handles and insulating guard disks or shields, so arranged as to make it unlikely that the hand will come in contact with live parts.

Switches below 300 volts to ground may be exempted from the above requirement.

(c) *Platforms or Mats*.—Where live parts of switches or automatic cut-outs operating at over 300 volts to ground are not remotely controlled, or provided with inclosing guards effective during ordinary operation or adjustment, or isolated by elevation, suitable insulating floors, mats, or platforms shall be provided on which the operator must stand while operating the switches or adjusting the automatic cut-outs. (See rule 115b.)

(d) *Working Spaces About Occasionally Exposed Live Parts*.—Where switches, disconnectors, and fuses above 750 volts are ordinarily guarded by covers or inclosed in separate rooms, but must occasionally be operated without such protection, either by removal of the covers or by entrance into the rooms, adequate working space shall be provided about the live parts (unless

effectively isolated by elevation as required by rule 116), so that the operator will not be required to bring any part of his body within the following horizontal distances:

Voltage of parts.	Distances in feet.
750 to 7 500	1
7 500 to 30 000	2
30 000 to 50 000	3
50 000 to 70 000	4
70 000 to 100 000	5
Above 100 000	6

(e) The distances given above are slightly greater than those required to be maintained by operators near parts of the corresponding voltages (see rules 441-442). This is for the purpose of providing against inadvertent movements of operators and to insure that operators of unusual height or size may be protected by the rule.

(f) Below 7500 volts the distance above specified may be reduced if the operator uses suitable operating devices.

Switchboards

170. Accessibility and Convenient Attendance

Switchboards shall have all switches so arranged that the points of control are readily accessible to the operator. Instruments, relays, and other devices requiring reading or adjustment shall be so placed that work can be readily performed from the working space. (See rules 169*d* and 176*c* and *d*.)

171. Location and Illumination

(a) Switchboards shall, where practicable, be so placed that the operator will not be endangered by any live or moving parts of machinery or equipment located near the board.

(b) Sufficient illumination shall be provided both for the front and rear of the switchboard so that the switchboard may be readily operated and instruments conveniently read.

172. Necessary Equipment

Switchboards which control outgoing supply circuits shall (except in sub-stations without regular attendance) be equipped with such instruments as are necessary to show operating conditions.

173. Arrangement and Identification

Connections, wiring, and equipment of switchboards and panel boards shall be arranged in an orderly manner and all switches and cut-outs shall be plainly marked, labeled, or arranged so as to afford ready means for identifying circuits or equipment supplied thru them.

174. Spacings and Barriers Against Short Circuit

(a) Switchboards shall have the number of bare parts at different potentials on any panel reduced to a minimum, and these parts shall be effectively separated. Protection or separation of such parts by suitable barriers is recommended where the voltage exceeds 750.

It is recommended that such parts, including bus bars, should be so located, or provided with such insulating coverings or barriers, that parts at different potentials will not be readily short-circuited by tools or other conducting objects.

(b) Fuses should be so located as to minimize the danger, in removing or replacing them, of short-circuiting parts at different potentials by the fuses or by the hands of the operator.

175. Grounding

Switchboard frames shall be permanently grounded under the conditions and with the exceptions noted in rule 113.

Where protective grounds are occasionally required on circuits for the protection of workmen, a permanent ground connection shall be provided, and also suitable means for effectively and readily connecting the parts being grounded to the ground connection. (See rule 163.)

176. Guarding Live Parts

(a) *Inclosure*.—All switchboards operating at over 300 volts to ground and located near passageways shall be guarded from these by suitable inclosures or barriers and shall (unless under constant attendance during operation) be made inaccessible to other than authorized persons.

(b) *Mats*.—For the protection of the operator, where parts over 300 volts to ground are not otherwise guarded or isolated by elevation, suitable insulating floors, mats, or platforms providing good footing shall be so placed that the operator cannot readily touch the live parts, unless standing on such floors, mats, or platforms.

(c) *Parts Over 750 Volts on Face of Board*.—No switchboard shall have exposed on its face within 6 feet from floor line any current-carrying part over 750 volts, except as noted in paragraph (e) below, and excepting direct-current railway boards up to 1500 volts, which, where above nominal 750 volts, shall be so constructed that the operator cannot inadvertently come in contact with parts having a hazardous difference of potential.

Dead face panels and remote control are recommended as means for accomplishing this result where isolation by elevation is impracticable or undesirable.

(d) *Exposed Live Parts on Face or Back*.—When working space adjacent to live parts cannot be provided in accordance with rule 114 (a) and (b), suitable guards shall be arranged to protect the operator from accidental contact with parts over 750 volts.

Suitable insulating guard rails, sufficiently spaced from the face or back of the board, or suitable guards perpendicular to the face or the back of the board, and extending out beyond the live parts, are recommended, where practicable.

(e) *Plug-type Switchboards*.—Plug-type switchboards should, except while connections are being changed, have

no current-carrying part exposed on face of boards and, if practicable, they and their plug connectors shall be so arranged where the operating voltage exceeds 150 as to have all current-carrying parts guarded so long as they are alive, even while connections are being changed.

(f) *Instruments*.—Metal cases of instruments (unless isolated by elevation) operating at over 750 volts should be grounded or inclosed in suitable covers of insulating material or of grounded metal.

(g) *Exposed Parts Over 7500 Volts*.—No switch-board shall have current-carrying parts above 7500 volts exposed (unguarded) unless these parts are effectively isolated by elevation, except at times when occasionally left exposed by removal of covers or entrance into inclosures, such as switch and instrument transformer cells or compartments, which are ordinarily unoccupied by persons. For such parts, if exposed while alive for any purpose (including busses and disconnectors in compartments), working space shall be provided complying with the requirements under rule 169d.

Lightning Arresters

180. Location

Lightning arresters when installed inside of buildings should be located as far as practicable from all other equipment and from combustible parts of the building.

181. Provisions for Disconnecting

(a) Lightning arresters on circuits over 7500 volts shall be so arranged, isolated, and equipped that they may be readily disconnected from conductors to which they are connected by air-brake manual disconnectors, having air gaps of not less than four times the equivalent needle point sparking distance of the operating voltage of the circuit to which the arresters are connected, and never less than eight inches.

(b) Such disconnectors, unless remotely controlled and operated, shall have the adjacent working spaces required by rule 169d, for disconnectors generally.

182. Ground Wires

Ground wires shall be run as directly as possible and be of low resistance and ample current capacity. (See Sec. 9.)

183. Grounding Frames

All noncurrent-carrying metal parts of arresters shall be grounded, unless effectively isolated by elevation, or guarded as required for live parts of the voltage of the circuit to which the arrester is connected, and suitably identified as of that voltage.

184. Guarding Live Parts

(a) All current-carrying parts of arresters on circuits above 750 volts, unless effectively isolated by elevation, shall be adequately guarded to protect persons from inadvertent contact with them, or from injury by arcing.

(b) Lightning arresters, unless provided with disconnectors, which are always opened before work is done on the arresters, shall be so arranged that necessary

adjustments are possible (without approach to current-carrying parts) through the use of permanently grounded mechanisms or suitable insulating appliances. Where charging or adjustments must be made with arresters alive, permanently grounded mechanisms or suitable insulating appliances shall always be provided.

(c) Guarding shall comply with the provisions of rules 115 and 152.

185. Utilization Installations

Lightning arresters when installed for the protection of utilization equipment may be installed on supply lines or service leads either within or without the buildings or inclosures containing the equipment to be protected, and the methods employed shall be in accordance with the rules governing the construction of overhead lines, supply stations, or utilization equipment, as they apply.

RULES FOR THE INSTALLATION AND MAINTENANCE OF ELECTRICAL UTILIZATION EQUIPMENT

Protective Arrangements

300. Scope of the Rules

(a) The following rules apply to electrical utilization equipment between 25 volts and 750 volts, where accessible to other than qualified electrical operators, as in mills, factories, mercantile establishments, hotels, theatres, and other public buildings, cars and other vehicles, dwellings, and similar places. Signal equipment connected to signal lines (see definition 4) is exempted, except from rules under Section 39.

(b) Equipment and conductors exceeding 750 volts, in addition to complying with the rules for stations and such of the following rules as apply, shall, where accessible to other than qualified electrical operators, have all ungrounded current-carrying parts either incased in permanently grounded metal cases or conduits, or otherwise suitably guarded to prevent access or too close approach to such current-carrying parts by any but specially authorized persons.

(c) Electrical utilization equipment, however, as well as generating equipment, if inclosed in a separate room which is inaccessible to unauthorized persons, and when in service is under the control of a qualified electrical operator whose attention is not distracted by other processes, shall be installed in conformity with the rules applying to Electrical Supply Stations (Part I) and does not come under these rules.

301. Application of the Rules

(a) The rules are intended to apply to all such installations except as modified or waived by the proper administrative authority or its authorized agents. They are intended to be so modified or waived in particular cases wherever any rules are shown to involve expense not justified by the protection secured or for any other reason to be impracticable; or wherever it is shown that equiva-

lent or safer construction can be more readily provided in other ways.

Other methods of construction and installation than those specified in the rules may be made as experiments to obtain information if done where supervision can be given by the proper administrative authority.

(b) The intent of the rules will be realized (1) by applying the rules in full to all new installations, reconstructions, and extensions, except where any rule is shown to be impracticable for special reasons, or where the advantage of uniformity with existing construction is greater than the advantage of construction in compliance with the rules; (2) by placing guards on existing installations or otherwise bringing them into compliance with the rules, except where the expense involved is not justifiable.

The time allowed for bringing existing installations into compliance with the rules will be determined by the proper authority.

(c) It will sometimes be necessary to modify or waive certain of the rules in cases of temporary installations or installations which are shortly to be discarded or reconstructed.

(d) In cases of emergency, or pending decision of the administrator, the person responsible for the installation may decide as to modifications or waiver of any rule, subject to review by proper authority.

302. General Requirements

(a) All electrical utilization equipment shall be of such construction and so installed and maintained as to reduce the life hazard as far as practicable.

(b) Compliance with the requirements of the National Electrical (Fire) Code for the installation of wiring and fittings is recommended.

(c) Where materials or devices are available which have been subjected to examination by some properly qualified body and found to comply with the general requirements of the National Electrical Safety Code, the National Electrical Code, and other non-conflicting accepted standards which apply for any given purpose, such materials or devices should be used in preference to others which have not been so examined regarding their suitability for the given purpose.

In order to avoid the necessity for repetition of such examinations by different examiners, frequently with inadequate facilities for such work, and to avoid the confusion which would result from conflicting reports as to the suitability of devices examined for a given purpose, it is necessary that such examinations should be made under standard conditions, and the record made generally available thru promulgation by organizations properly equipped and qualified for experimental testing, inspections of the run of goods at factories and service value determinations thru field inspections, and whose findings are subject to appeal to the Bureau of Standards.

303. Inspections and Repairs

(a) Electrical utilization equipment shall comply with these safety rules when placed in service, and shall thereafter be periodically inspected, and when necessary, cleaned. Defective equipment shall be put in good order or permanently disconnected. Defective wiring, where hazardous, shall be repaired or removed.

(b) Repairs, extensions, and changes should be made to existing utilization equipment and conductors only by properly qualified persons.

304. Grounding

(a) *Grounding Method.*—All lightning-arrester grounding and all grounding of circuits, equipment, or wire runways, which is intended to be a permanent and effective protective measure shall be made in accordance with the methods specified in section 9.

(b) *Circuits Required to be Grounded.*—All circuits installed in rooms to which other than properly qualified electrical workmen have access, or in rooms where non-electrical processes are liable to distract the attention of the electrical operator from the purely electrical operations, shall be permanently grounded in accordance with the rule No. 9, Method for Protective Grounding, except that the following circuits are not required to be grounded:

(1) Circuits on 2-wire direct-current systems.

(2) Circuits entirely unexposed to leakage or induction from higher-voltage circuits, either through overhead construction or through transformers or other devices.

It is recommended, however, that all 3-wire (not delta 3-phase) circuits, even if unexposed, have their neutrals grounded; and that multiphase circuits, even if unexposed, where partly used for lighting, be so arranged and grounded that the lighting circuits have the lowest practical voltage ground.

(3) Circuits over 150 volts to ground. (See rule 306.)

(4) Electric furnace and welding circuits. (See rule 352.)

(c) *Grounding Noncurrent-Carrying Metal Parts.*—Under the hazardous conditions named below fixed electrical utilization equipment shall, when practicable, have the exposed noncurrent-carrying metal parts, such as frames of motors, cranes, cars, and switchboards, cases of transformers and oil switches, and casings of wiring and conductors permanently grounded. (See Sec. 9, and for grounding of portable devices see section 37.)

The following conditions shall be considered hazardous:

(1) All operation at voltages over 150 to ground, wherever equipment is located.

(2) All locations where explosives, inflammable gas, or inflammable flings normally exist in dangerous quantities.

(3) All cases where exposed grounded surfaces, such as metal frames of other machines, plumbing fixtures, conducting floors or walls, exist within the reach of persons when touching the metal parts under consideration.

Usually grounded surfaces within 5 feet horizontally of the parts considered and within 8 feet vertically of the floor are considered "within reach."

(d) *Exceptions*.—Except in cases (2) and (3) under the preceding paragraph, no ground connection need be made to exposed metal frames of switchboards, motors, or lighting fixtures connected to direct-current trolley or third-rail circuits, provided that such frames are effectively insulated from ground, and provided that the metal frames in question are so located with reference to insulating floors or platforms that persons cannot readily touch the metal frames in question without standing on such floors or platforms.

(e) Parts of machines, such as name-plates, screws in wood, and similar small parts which are not liable to become alive, except under very unusual circumstances, are not considered as coming under the rule and may be left ungrounded.

305. Working Space About Electrical Equipment

(a) Suitable working space should be provided and maintained about all electrical utilization equipment.

(b) The working spaces should, where practicable, have minimum horizontal dimensions, where adjacent to exposed live parts within 8 feet of floor, as follows:

(1) Parts above 150 volts to ground, if on one side, 2.5 feet; if on two sides, 4 feet.

(2) Parts below 150 volts to ground, if on one side, 1.5 feet; if on two sides, 2.5 feet.

(c) Where adjacent to such exposed live parts, working spaces should be so arranged that they will not be used as passageways.

(d) The elevation of the equipment at least 8 feet above ordinarily accessible working platforms affords protection at least equivalent to that provided by the horizontal clearances of (b), and may be used in lieu thereof, if desired.

306. Guarding or Isolating Live Parts

(a) All ungrounded current-carrying parts of electrical utilization equipment, such as bus bars, conductors, and terminals, operating at over 150 volts to ground and not isolated by elevation at least 8 feet above floor line should, where practicable (for exception see paragraph b), be provided with suitable permanent inclosures or other guards arranged so as to prevent persons or conducting objects from inadvertently coming (or being brought) in contact with the parts in question, and at the same time so as to permit ready access to authorized persons for making adjustments or repairs.

Inclosures may consist of suitable casings or suitable insulating coverings. The continuous insulating covering of conductors should be depended upon only when the circuit is grounded or entirely unexposed to leakage or induction from higher voltage circuits, and where it is impracticable to install more suitable guards. It should be depended upon then only when the

covering is not exposed to liability of mechanical injury (see rule 313b), and is very substantial, thoroly dry, and contains no noninsulating flame-proofing compound or oil-soaked rubber. It is recommended that in addition to the protection afforded by such coverings the insulating mats or platforms called for in paragraph (b) be used.

Where covers, casings, or barriers must at any time be removed from the otherwise exposed current-carrying parts which they guard, while these parts are alive, the covers, casings, or barriers should be of insulating material, or so arranged that they cannot readily be brought in contact with the live parts.

Mats may be of wood, held together by wood pins, or of cork matting, linoleum, or rubber. The material and construction should be suitable for the voltage concerned and for the prevailing conditions. If subject to moisture or to accumulations of conducting dust, flyings, or chips, mats should present surfaces minimizing the hazards from these sources.

(b) Where current-carrying parts at over 150 volts to ground must necessarily be exposed (unguarded) within 8 feet from the floor line, all surrounding conducting floors and other noncurrent-carrying surfaces within reach shall be covered with suitable insulating platforms, mats, or other insulating devices. (See rule 305 for working space.)

The guarding of current-carrying parts will obviate the necessity for such insulating devices, and where the use of the latter is impracticable, from the nature of the location or processes carried on, guards should always be used.

(c) Except on fenced rights of way or other locations to which only qualified persons are admitted, trolley or crane collector wires and third rails, whether indoors or out, shall be so isolated by elevation (see rule 116, and section 24) or be provided with suitable guards so arranged that persons cannot inadvertently touch the current-carrying parts while in contact with the ground, or with conducting material connected to the ground, and shall be provided with warning signs effective whenever the conductors are alive.

Damp wood, concrete floors, and metal parts of crane cabs are considered as grounded.

Trolley-contact conductors indoors shall be so supported that in case of a single break contact with the floor cannot be made.

(d) Bare parts at different potentials shall be effectively separated. Such parts in circuits of large capacity or operating at over 300 volts shall, where practicable, unless provided with the inclosure or other guard specified in (a) above, be provided with suitable bar-

riers, if otherwise they would be liable to be short-circuited by tools or other conducting objects.

307. Hazardous Locations

(a) In locations where explosives, inflammable gas, or inflammable flyings normally exist in dangerous quantities all parts at which sparking or arcing is liable to occur shall be so inclosed as to reduce the hazard as far as practicable.

(b) This protection should be obtained by one of the following methods:

(1) By placing in separate compartments or rooms, free from explosives, inflammable gas and inflammable vapors.

(2) By using casings of the inclosed type (ventilated, if necessary) when dust or flyings are present.

(3) By using explosion-proof casings when inflammable gases exist in dangerous quantities.

(c) All casings shall be nonabsorptive and noncombustible, and when of metal shall be permanently grounded, if within reach of grounded surfaces, or if inflammable gas is present.

308. Storage Batteries, Transformers, and Lightning Arresters

(a) The installation of nonportable storage batteries above 50 kilowatt-hour capacity, at the 8-hour rate of discharge, shall be in accordance with the requirements given in section 13 of the rules for stations. Where small storage batteries (not included under section 13) are placed in rooms used also for other purposes, adequate guards or inclosures shall be provided, when necessary, to prevent the approach of unauthorized persons, and special means of ventilation when necessary to prevent the accumulation of inflammable gas. For all batteries whose operating voltage exceeds 150, construction shall comply with rules 133 and 306b.

(b) The installation of transformers having either winding over 300 volts to ground shall comply with the rules of section 14 of the rules for stations, and if the operating voltage of any winding exceeds 750, the transformers shall be made inaccessible to unauthorized persons. (See also rule 304c and discussion in Sec. 14.)

(c) The installation of lightning arresters shall comply with the rules of section 18 of the rules for stations and, if the operating voltage of the circuit exceeds 750 volts, the arresters shall be made inaccessible to unauthorized persons.

309. Identification

(a) All electrical utilization equipment shall be suitably identified, when necessary for safety.

(b) The identification may be by position, color, number, name-plate, label, design, or other means.

(c) The voltage and intended use shall be shown where important.

Conductors

310. Electrical Protection

(a) Conductors shall be suitable for the location, use, and voltage, and each conductor (except neutral con-

ductors, ground wires, and conductors of circuits the opening of which may cause special hazard by the interruption of service or removal of protection) shall be protected against excessive current by a suitable automatic cut-out or by the design of the system.

(b) Neutral conductors in 3-wire systems shall be arranged without automatic cut-outs interrupting their continuity, unless the cut-out opens all conductors of the circuit with one operation. Switches in 3-wire circuits shall open all conductors of the circuit with one operation, except that the switch may be omitted from the neutral. The neutrals shall everywhere be of sufficient size to safely carry the maximum current in either outer conductor at that point.

In 2-wire branches from 3-wire circuits the conductor connected to the neutral is not for the purpose of this rule considered a neutral conductor.

(c) All conductors normally grounded for the protection of persons shall be arranged without automatic cut-outs interrupting their continuity between the source of electrical supply and the point at which the ground wire is attached, unless the cut-out opens all conductors of the circuit with one operation. Switches shall open all conductors of the circuit with one operation, except that the switch need not be placed only on ungrounded conductors of the circuit, except that this does not necessarily apply to single-pole key sockets which may be used and in which the switch may be placed on the grounded side.

Where the utilization equipment is connected to electrical supply lines, the point of connection to the service leads is considered as the source of electrical supply.

The identification of neutral and grounded conductors by some suitable marking will facilitate compliance with the rule.

311. Mechanical and Thermal Protection

(a) Where exposed to mechanical injury, suitable casing, armor, or other means shall be employed to prevent injury or disturbance to conductors, their insulation, or supports. Conductors used as meter loops shall be substantially supported clear of objects other than their insulating supports, and separated from each other, or shall be in approved conduit or substantial noncombustible, nonabsorptive casings.

(b) Where conductors with combustible insulating coverings are closely grouped (as sometimes on the rear of switchboards or in cableways) they shall have a substantial noncombustible outer covering. Conductors in very hot locations shall have a noncombustible insulating covering.

(c) Bare conductors shall be used only for switchboard, panel-board, or storage-battery connections; or for electrolytic, low-voltage furnace, or low-voltage welding circuit, and similar connections; or for trolley wires, third rails, and other contact conductor, and parts at different

potentials. Such bare conductors shall be fixed at adequate separations by the use of suitable supports. Except at the point where a permanent ground connection is made such conductors within buildings shall be kept insulated from the ground. Bare conductors shall not be used where inflammable gases or explosives are liable to exist in large quantities. (See rules 306 and 312 for guarding requirements; also see rule 91c.)

312. Isolating or Guarding

All fixed conductors having insulating coverings and operating at over 300 volts to ground, and bare conductors at all voltages shall (unless guarded as required in rule 313) be so isolated by elevation (as required by ruled 306a) that no person can inadvertently come or bring conducting objects in contact with them.

313. Guarding Conductors

(a) *Use of Inclosing Casings.*—For inclosing insulated conductors, approved permanently grounded metal conduit, waterproof insulating conduit, or grounded metal sheathing shall be used, except that in dry places, ducts, runways, or compartments of suitable fire-resistive material, may be used for conductors below 750 volts, if containing no exposed combustible material. (See rule 318 for further exception). In damp places conduit shall be made waterproof and provided with suitable means for draining off condensation, unless the conductors contained are lead-sheathed cable.

(b) *Open Conductors Below 750 Volts.*—Where open insulated conductors between 300 volts to ground and 750 volts, or open bare ungrounded conductors at any voltage below 750 volts (except bare wires used at high temperatures in heating devices, at voltages not exceeding 300 volts to ground) are necessarily brought closer to the floor line than 8 feet, they shall be guarded by permanent screens or inclosures.

(c) Where persons at any time remove or pass by screens or other guards for bare conductors while such conductors are alive, such screens or guards shall be of insulating material, and all conducting floors, walls, machine frames, and similar surfaces within 8 feet below the conductors or 3 feet horizontally from them, shall be covered with suitable insulating platforms, mats, or covers. (See rule 306b.)

Dependence should not be placed on the unprotected insulating covering as a suitable guard or inclosure for such conductors near the floor line, nor in certain other cases (see rule 306a). Other guards should be provided to protect the insulation against mechanical injury and to secure the safety of persons who must come near the conductors.

314. Guarding in Damp or Hazardous Locations

(a) Conductors in damp locations or where exposed to corrosion, if not in waterproofed conduit, or in waterproof metal sheaths in other suitable ducts, shall be effectively isolated and supported on insulators of a suitable type.

(b) Conductors in locations where inflammable gas or flyings normally exist shall be in grounded metal conduit or metal-sheathed cable. All fittings and outlets of such conduit and cable shall be electrically and mechanically continuous with the conduit or metal sheath, and the conduit shall be sealed by the use of suitable potheads or equivalent devices to prevent entrance of gases.

315. Precautions to Avoid Excessive Inductance and Eddy Currents

Supply conductors of alternating-current or direct-current circuits should not be run in separate iron conduits or on opposite sides of I-beams or other iron structures or be otherwise run so as to increase abnormally the self-inductance of the circuit.

Such construction, by introducing large self-inductance in direct-current circuits, causes fuses to blow explosively; in alternating-current circuits it causes heating due to eddy currents in the metal.

316. Pendants and Portables

Pendants or portable conductors shall not be installed or used on circuits operating at over 300 volts to ground, unless they are accessible only to persons authorized to approach them. In such cases they shall be of a type suitable for the voltage and conditions, and conform to the rules of section 37.

317. Taping Ends and Joints

Ends and joints of insulated conductors, unless otherwise adequately guarded, shall have equal insulating covering with other portions of the conductor, and this covering shall be securely held in place.

318. Grounding or Isolating Service Conduits

(a) Metal conduit or sheathing encasing service conductors from either overhead or underground lines shall either be (1) permanently grounded as required by rule 304, or (2) effectively isolated by elevation. (See rules 304 and 306.)

(b) If not grounded, the service conduit or sheathing shall be effectively insulated from metal work of the building, and from its piping. Where service conduit or sheathing is electrically continuous with interior conduit either be (1) permanently grounded as required by rule 304c) shall be made direct to the service conduit or sheathing and shall have conductance not less than that of No. 6 copper wire.

(c) Where grounded service conduit or sheathing is insulated from interior conduit or sheathing, its ground wire conductance need not exceed that required under section 9, for equipment ground wires.

It is frequently advisable to insulate interior conduit or sheathing from underground service conduit or sheathing, to prevent burnouts of small interior conduit, armored cable sheaths or metal molding, by large currents which might flow from grounded circuits through the interior metal to water pipes or other good ground connections within the building.

319. Temporary Wiring

Temporary wiring and equipment, which is not in compliance with these rules, may be used, but only when under competent supervision, or protected by suitable barriers or warning signs while it or neighboring wiring is alive and accessible to any person.

*Fuses and Other Cut-Outs, Switches and Controllers***320. Accessible and Indicating**

All switches, automatic cut-outs, controllers, starting rheostats, auto-starters, and other control devices shall be readily and safely accessible to authorized persons; they shall be so located or marked when controlling circuits of over 1320 watts, as sufficiently to indicate their function and the location and character of the equipment controlled by them and whether they are open or closed. They shall be so installed as to minimize the danger of accidental operation. Where practicable, they shall be so installed that gravity cannot close them; and such switches as close by gravity shall be provided with a proper stop block or latch to prevent accidental closing.

Switches controlling emergency lighting circuits, elevator circuits, circuits in theatres, hospital operating rooms, and other circuits, the interruption of which might cause special hazard, shall be arranged so as to be accessible only to authorized persons.

321. Hazardous Locations

When necessary to install fuses or other automatic cut-outs, or switches or other control devices in locations where explosives, inflammable gas or inflammable flyings exist, they shall be suitably protected. (See rule 307.)

322. Where Switches are Required

(a) Suitable switches shall be inserted in all feeder conductors connecting utilization installations to service connections from either overhead or underground lines. These switches shall be readily accessible, and as close as practicable to the point of connection with overhead or underground lines.

(b) Suitable switches shall be inserted in all circuit leads (except a grounded conductor, see rule 310) to motors, transformers, storage batteries, electric furnaces, and similar utilization equipment, except between parts or pieces of apparatus intended to operate as a unit.

Switches installed for use on lighting and similar circuits under 1320 watts are not required to interrupt all conductors of the circuit.

(c) Switches or plug connectors shall be placed in all circuit leaders at the point where temporary wiring or portable conductors are connected to the permanent wiring.

323. Character of Switches and Disconnectors

(a) *Capacity.*—Switches used otherwise than as disconnectors shall have a rated capacity such as to insure safe interruption, at the working voltage, of the greatest current which they will be required to carry continuously,

and shall be marked with the current which they can safely interrupt.

Rating means that they should operate successfully at 50 per cent. overload in amperes and at the working voltage under the most severe conditions which they are liable to meet in practice.

(b) Disconnectors shall be of suitable voltage and ampere rating of the circuit in which they are installed and shall be accessible only to properly qualified persons. They shall also be protected by signs warning against opening the switches while carrying current in excess of the safe opening limit.

Interlocking arrangements are desirable to prevent opening of such disconnectors under loads beyond their safe opening capacity.

(c) *Locking or Blocking.*—Means shall be provided so that switches controlling motors, storage batteries, transformers, electric furnaces, and similar utilization equipment can be locked or blocked in the open position and plainly tagged to prevent careless closing while work is being done on the equipment controlled by them, unless all live and moving parts of controlled equipment which would cause a hazard are so guarded as to render locking or blocking unnecessary.

Small capacity snap switches, if near machines and in plain sight from all parts of the machines controlled, are exempted. Switches of any size are exempted if the installation comprises only one motor, and the switch is in plain sight from all parts of the machines operated by the motor.

Locking is recommended rather than blocking, wherever parts of the machinery driven are remote from the point of control.

(d) *Good Contact.*—Switches, controllers, and rheostats shall be so constructed as to make and maintain good contact. Knife switches shall maintain such alignment under service conditions that they may be closed with a single unhesitating motion.

324. Disconnection of Fusible Cut-Outs Before Handling

(a) Fusible cut-outs in circuits operating at over 150 volts to ground, shall, if practicable, where accessible to others than qualified electrical attendants, be so arranged that the ungrounded current-carrying parts cannot be touched by persons re-fusing the cut-out until the fuses have been disconnected from all sources of electrical energy. Where the circuit voltage exceeds 300 to ground, this arrangement shall always be made. It is recommended that where practicable this protection also be provided for fusible cut-outs in circuits operating below 150 volts to ground.

This may be accomplished by a construction in which the fuse and its exposed current-carrying connections are accessible only after they

have been disconnected from the circuit, either by opening the fuse inclosure or by other means.

(b) On circuits not exceeding 150 volts to ground, where the fusible cut-outs are not arranged so that they are necessarily disconnected from all sources of electrical energy before the ungrounded current-carrying parts can be touched, it is recommended that switches be so placed or arranged that opening them will disconnect the fuses from all sources of electrical energy.

On circuits between 150 and 300 volts to ground, where fusible cut-outs are not arranged so that they are necessarily disconnected from all sources of electrical energy before the ungrounded current-carrying parts can be touched, switches shall always be so placed or arranged that opening them will disconnect the fuses from all sources of electrical energy unless portable insulating appliances are provided for handling the cut-outs.

(c) Where fusible cut-outs are in locked cabinets or otherwise made inaccessible to all but qualified persons, sufficient protection is usually secured, even for voltages above 300, by the use of switches accessible only to such persons, these switches to be placed or arranged so that their operation will disconnect the fuses from all sources of electrical energy.

325. Arcing or Suddenly Moving Parts

(a) Fuses and circuit-breakers shall, as far as possible, be so located and shielded that persons will not be burned by their operation.

(b) Handles or levers of circuit-breakers and similar parts which may move suddenly in such a way that persons in the vicinity are liable to be injured by being struck by them shall be guarded or isolated, where practicable.

326. Grounding Noncurrent-Carrying Metal Parts

Exposed noncurrent-carrying metal parts of switch and fuse cases, levers, and other similar parts to which leakage may occur from live parts shall be permanently grounded according to the provisions of rule 304.

Parts of machines, such as name-plates, screws in wood, and similar small parts which are not liable to become alive except under very unusual circumstances are not considered as coming under the rule and may be left ungrounded.

327. Guarding Live Parts of Switches and Automatic Cut-outs

(a) All manual switches (with the exception stated below) shall have suitable casings or guards protecting the operator from danger of contact with current-carrying parts, or shall be provided with insulating handles and suitable insulating guard disks or shields so arranged between the handles and the live parts as to prevent the hand from slipping into contact with live parts or being burned by arcing at the switches.

Switches under 150 volts to ground and limited to 60 ampères by cut-outs in series are

not required to conform with the above paragraph.

(b) Current-carrying parts of switches or automatic cut-outs operating at over 150 volts to ground shall be provided with inclosing guards, effective during ordinary operation, if accessible to other than properly qualified persons.

Switches or automatic cut-outs operating at over 150 volts to ground and having current-carrying parts exposed may be made inaccessible to other than properly qualified persons by inclosure in locked cabinets or rooms.

(c) Where switches or cut-outs above 150 volts to ground are not guarded during operation suitable insulating floors, mats, or platforms shall be provided on which the operator must stand while operating the switches or adjusting automatic cut-outs, and (unless operators invariably wear suitable insulating gloves while handling the switches) any conducting walls or machine frames within 3 feet shall be provided with suitable insulating guards.

The suitable guarding of live parts will obviate the necessity for such insulating floors and other devices, and where use of such devices is impracticable from the nature of the location or mechanical process carried on, guards should always be used.

(d) Switches shall, if practicable, be so connected as to have no live blades exposed to contact when a switch is open.

Switchboards and Panel Boards

330. Accessibility and Convenient Attendance

(a) Switchboards and panel boards shall have all switches so arranged that the means of control are readily accessible to the operator.

(b) Instruments, relays, or other devices requiring reading or adjustment shall be so placed that work can be readily performed from the working space provided. (See rule 335.)

331. Location

Switchboards shall, where practicable, be so placed that the persons necessarily near the board will not be endangered by machinery or equipment located near the board. Means for adequate illumination shall be provided.

332. Arrangement and Identification

(a) Connections, wiring, and equipment of switchboards and panel boards shall be arranged in an orderly manner and all switches and cut-outs shall be plainly marked, labeled or arranged so as to afford ready means for identifying circuits or equipment supplied through them.

It is recommended that a diagram of switchboard or panel-board connections and devices be kept posted in some convenient place near such equipment.

(b) Switchboards shall have current-carrying parts which are ordinarily isolated or guarded, but which may occasionally require adjustment or repair while alive, so arranged that suitable portable covers or shields can be effectively placed to protect workmen from contact with any neighboring live parts.

333. Spacings and Barriers Against Short Circuit

(a) Exposed bare parts of different potential or any switchboard or panel shall be as few as practicable and these parts shall be effectively separated.

(b) Such parts, including bus bars, should, when practicable, be so located or provided with such barriers or substantial insulating coverings that parts of different potential will not be accidentally short-circuited by tools or other conducting objects.

334. Grounding Frames

Switchboard frames and metal cabinets should be permanently grounded, under the conditions and with the exceptions noted in rule 304.

335. Guarding Current-Carrying Parts

(a) All switchboards and panel boards having exposed current-carrying parts operating at over 150 volts to ground and not isolated by elevation at least 8 feet above the floor shall when practicable be suitably inclosed in locked cabinets, screens, or rooms, or other inclosures to make them inaccessible to others than the authorized operator. Conducting floors about such boards shall be provided with a suitable insulating platform or mat so placed that no person can inadvertently touch live parts unless standing on the insulating platform or mat. (See rules 306 and 327a.) Where the circuit voltage exceeds 300 to ground this arrangement shall always be made.

(b) Where switchboards or panel boards at voltages below 150 to ground are accessible to other than properly qualified operators, they should, where practicable, be inclosed in cabinets or screens as an effective precaution against accidental short-circuits (see rule 333) at times when no operation of the board necessitates the opening of the cabinet or screen.

(c) Plug type switchboards on constant-current systems, or if above 150 volts to ground, shall have no current-carrying parts exposed on face of boards, and plug connectors shall have all current-carrying parts guarded as long as they are alive.

(d) Switchboards having no current-carrying parts exposed at the face (working space) are recommended for use in theatres and similar places where rapid handling is necessary, and the attention must be given to signals or to other processes.

(e) Theatre switchboards at any voltage, if having current-carrying parts exposed at the face, should, where practicable, be elevated, or guarded by suitable railings, to prevent contact with live parts by passers-by.

Motors and Motor-Driven Machinery

340. Control Devices

(a) Separately excited direct-current motors, also series motors, and motor generators and converters larger

than 10 kilowatts where it is possible for them to be driven at excessive speed from the direct-current end, as by a reversal of current or decrease in load, shall be provided with speed-limiting devices, unless the load and the mechanical connection thereto are of such a character as to safely limit the speed.

(b) Where the speed control of direct-current motors is accomplished by varying the field resistance, and the nature of the load and the range of the field rheostat are such as to make a dangerous speed attainable, and no speed limit devices are used, the field rheostats shall be arranged with no-voltage releases or other devices so that the motor cannot be started or continued in operation under dangerously weakened field, except where the operation of such a no-voltage release might result in serious injury to service or apparatus.

Motors which are designed to permit starting safely under weakened field are not included in the above.

(c) Manually controlled starters for motors shall be so designed and circuits so arranged that they return automatically to the "off" or starting position upon failure of the energy supply, except where the motors and their starting devices are, during operation, under supervision of qualified persons and equivalent protection is otherwise provided.

(d) Where speed-limiting devices or remote-control switches are electrically operated, the control circuits by which such devices are actuated shall be adequately guarded, by conduit or otherwise, against mechanical injury.

341. Hazardous Locations

Motors in which sparking or arcing can occur during operation, shall where practicable be kept out of locations where explosives or inflammable gas or inflammable flyings exist. Where necessarily in such locations they shall be suitably protected. (See rule 307.)

342. Deteriorating Agencies

(a) Suitable guards or inclosures shall be provided to protect exposed current-carrying parts of motors and the insulation of motor leads where installed directly under equipment or in other locations where dripping oil, excessive moisture, steam, vapors, chemicals, or similar injurious agents exist.

(b) The metal frames and other exposed noncurrent-carrying metal parts of equipment in these locations shall be permanently grounded. (See rule 304c.)

343. Guards for Live Parts

(a) Motors operating at over 150 volts to ground, unless isolated by elevation at least 8 feet above the floor line, should, if practicable, be provided with permanent inclosures or other suitable guards so arranged as to prevent persons or conducting objects from inadvertently coming or being brought into contact with live parts or interfering with the operation of the motors.

(b) Suitable insulating mats or platforms of substantial construction and providing good footing shall be

so placed on floors and, if necessary, on frames of machines having exposed live parts above 150 volts to ground that the operators or other persons in the vicinity cannot readily touch such parts unless standing on the mats, platforms, or insulating floors.

The suitable guarding of live parts by inclosures or barriers effective during attendance or necessary adjustments of live parts will obviate the necessity for insulating mats, and, where such mats are impracticable from the nature of the location or processes carried on, guards shall always be used.

Where connectors are used in motor leads, these should be provided with insulating covering equal to that on the conductors.

(c) Where necessary, steps and handrails should be installed on or about large machines to afford safe access to live parts which must be examined or adjusted during operation.

(d) Where two or more machines, either of which operates at over 150 volts to ground, are mechanically coupled together, and the operator can touch the frames of more than one at a time, the frames of all such machines shall be permanently grounded, unless they are bonded together electrically and surrounded by insulating mats or platforms on which persons must stand in order to touch the machine frames. If operating at above 300 volts to ground, their frames shall always be grounded, and frames shall also be grounded wherever, from the nature of the location or of processes carried on, the use or maintenance of insulating mats or platforms is impracticable. (See rule 304c.)

344. Protecting Moving Parts

Suitable guards or inclosures shall be arranged at each motor or motor-driven machine when necessary to prevent persons or objects from inadvertently coming in harmful contact with moving parts, including chains, belts, gears, and pulleys.

Electric Furnaces and Welders

350. Protection from Burns

(a) Electric furnaces and apparatus used for arc welding, where intensely glowing, incandescent, or arcing parts are exposed, shall be inclosed, so that those parts will not be accessible or visible to unauthorized persons.

(b) Suitable protecting screens, hoods, goggles, gloves, and other devices shall be provided for the authorized operators who must work or come near such exposed parts.

351. Grounding

The outside noncurrent-carrying metallic frames of furnaces shall be permanently grounded if they contain current-carrying parts connected to circuits above 150 volts to ground, or if the circuit within is not grounded and is exposed through transformer windings to a circuit over 150 volts to ground.

352. Guarding Live Parts

Except at points where necessarily left exposed (as at spot welder contacts) all current-carrying parts of furnaces, welders, and control equipment shall be suitably guarded with inclosures or barrier guards.

Lighting Fixtures and Signs

360. Grounding

The exposed noncurrent-carrying metal parts of all lighting fixtures and other similar fixed electrical devices shall be permanently grounded when used under the following circumstances (for exception, see rule 304d). (1) When in locations where explosives, inflammable gas, or inflammable flyings normally exist in dangerous quantities; (2) when within touching distance or about 8 feet from metal, concrete, or permanently damp floors or stairways, including fire escapes, galleries, or bridges, as in machine shops, stables, laundries, etc.; (3) when readily accessible from the ground or floor and also within 5 feet from conducting surfaces, such as metal piping, metal radiators, stoves, furnaces, plumbing fixtures, damp walls, or similar conducting surfaces, as in kitchens, machine shops, print shops, etc.

On grounded systems it is recommended that the centre contacts of sockets and receptacles be connected to the ungrounded side of the system, and the inner screw shell of the devices to the grounded side or neutral, in order to reduce the liability of breakdown of the dielectric between the inner screw shell and the grounded outer brass shell, and also to reduce the liability of injury to persons in replacing lamps. This is especially important in wiring electric signs.

In lieu of grounding the external metal parts of lamp sockets, where suitable means for grounding are not readily available (as sometimes is the case with knob and tube wiring not near plumbing fixtures), sockets and lamp guards or similar devices of suitable insulating material may be used. It may be preferable, however, to place the socket itself out of reach and arrange for its operation by a chain pull, having adequate insulation in the chain.

361. Insulation

Electric fixtures shall be provided with an adequate and mechanically protected dielectric (complying with the standardization rules of the A. I. E. E.) interposed between ungrounded current-carrying parts and those external surfaces which persons can touch.

Those current-carrying parts of grills, heaters, and other heating devices, which operate at high temperatures and are necessarily exposed, are exempted. (Compare rule 352.)

362. Exposed Live Parts

Electric fixtures, including lamp sockets and lamp bases, plugs, receptacles, etc., shall be so designed and

installed that no current-carrying parts will normally be exposed externally. (For exception see rule 361.)

363. Accessibility and Guarding of Signs

(a) Electric signs at an elevation greater than 30 feet above roadways or footways, or at an elevation above a roof greater than the distance from the edge of the roof, shall, if they require attendance while in position, be provided with substantial, safely accessible runways, ladders, or platforms from which all replacements and other necessary adjustments can be made. Provision for supporting workmen by safety belts should be made in the construction and installation of signs so located.

(b) Electric signs outside buildings shall have no ungrounded current-carrying parts normally exposed to contact of workmen on or in the building. (Compare rule 313b.)

(c) The exposed noncurrent-carrying metal parts of a sign should be grounded if within reach of any grounded surfaces, including metal work of the building structure.

364. Control of Outdoor Signs

Electric signs, located as noted in rule 363, shall be provided with switches arranged to entirely disconnect all feed wires of the sign, and either located within sight of the sign or arranged so that they can be locked in the open position.

365. Connectors for Signs

Electric signs shall be so arranged that changeable connections can be made manually only by approved connectors in which all poles of the circuit are simultaneously interrupted. All current-carrying parts of pin and socket connectors shall be provided with approved guards; so as not to be exposed to contact.

366. Isolating or Guarding Lamps in Series Circuits

(a) Arc and incandescent lamps and other devices in series circuits, except in grounded circuits of which no part exceeds 150 volts to ground, shall be effectively isolated or suitably guarded.

(b) All metal cable or chain supports for lamps shall be effectively insulated from the lamp or shall be permanently grounded.

Isolation will ordinarily be deemed sufficient when a vertical clearance of 8 feet is provided from floors or other ordinarily accessible places within buildings of 10 feet from footways outside buildings, and of 15 feet from roadways. Horizontal clearance from windows, porches, and other spaces accessible to the general public should be not less than 3 feet.

(c) Lamps shall be secured from falling on persons or traffic passing below, and the hanger, rope, chain, or other means adopted for holding the lamps shall be regularly and systematically inspected. Metal chains or wire cables used for lowering lamps in series circuits shall be interrupted by a suitable strain insulator the minimum height of which from the floor or ground shall be 8 feet, whether the lamp is in position or lowered.

367. Safe Access to Arc Lamps

A suitable device shall be provided by which each arc lamp or other device on series circuits may be safely and entirely disconnected from the circuit before it is handled, unless the lamps are accessible only to properly qualified persons, worked on only from suitable insulating stools, platforms or tower wagons, and treated always as under the full voltage of the circuit concerned.

Portable Devices, Cables, and Connectors

(Not Including those for Signal Systems)

370. Insulation

(a) Portable devices shall be provided with an adequate dielectric (complying with the standardization rule of the A. I. E. E.) interposed between ungrounded current-carrying parts and those external surfaces which persons can touch.

Toasters, grills, or other heating devices in which the current-carrying parts at high temperature are necessarily exposed, are exempted. (Compare rules 352 and 361.)

(b) In locations where the dielectric is exposed to mechanical injury it shall be suitably protected.

371. Grounding

(a) The permanent grounding of frames of portable devices (especially in connection with voltages above 150 to ground, and for any voltage when the devices are used within 8 feet of the floor in locations such as bathrooms, laundries, etc., where persons may easily touch grounded surfaces at the same time as the device) is recommended as a safety measure, where this is practicable and suitable means are available, but cannot, of course, be reasonably required unless such means are available.

Such grounding may be obtained by the use of a 3-wire portable cord with the portable device, one wire being used for the ground conductor and the connectors being properly designed so that wrong connections cannot be made by the user of the device.

(b) In lieu of grounding the external metal parts of portable lamp sockets where suitable means (as above indicated) are not readily available, sockets and lamp guards or other similar devices of suitable insulating material may be used, and should be used in the hazardous locations listed previously.

372. Cable Connectors

(a) Where used with portable conductors it is recommended that connectors be used which necessarily disconnect both or all poles from the live source of energy where the circuit is opened.

(b) Connectors shall be so constructed (with guards when necessary) that the person using them cannot inadvertently come in contact with live parts, or be burned by arcing when interrupting the largest current for which they are rated or marked.

(c) The end of a separable connector which is left alive, or the two ends of a separable connector where both are connected to live circuits (as in battery charging), shall have live parts suitably guarded.

(d) Where connectors are attached to portable cables, suitable means shall be provided for relieving the terminal connections of cable from strains.

(e) Separable connectors should, where practicable, be so designed that the plugs will not fit receptacles rated for larger currents than the plugs.

373. Identified Conductors, Cords, and Connectors

Where used with portable devices, the cases of which are designed to be grounded (see also rule 371), the portable cable and the separable connectors (both to the device and to the circuit) shall, where practicable, be provided with identified parts; so that the ground conductor wire in both the fixed wiring and portable cable will always be attached to the proper terminals of the connectors. It is desirable that the fixed wiring also have suitable marking to distinguish the ground conductor from circuit conductors.

Separable connectors shall be so constructed that wrong connection between the two parts is impossible.

374. Use of Portables and Pendants

(a) Portable and pendant conductors shall not be installed or used on circuits operating at over 300 volts to ground, unless they are accessible only to persons authorized to approach them. In such cases they shall be of a type suited to the voltage and conditions.

In car houses and similar locations where service at low voltage is not available and where necessary to use low-voltage pendant, or portable lamps or other devices in series with lamps on trolley circuits, the devices should be used only with great caution and be placed preferably on the grounded side of the circuit concerned.

(b) Where portable conductors are required, fixed sockets or connectors shall be provided at safely accessible points, attached, where practicable, to the grounded side of the circuit, and so located that liability of such conductors being brought into dangerous proximity with other live parts will be reduced as far as practicable.

(c) Where exposed to dampness or corrosive influences, portable conductors shall be of a type specially suited, and where exposed to inflammable gas or flyings they shall be so protected or isolated by elevation that they cannot be readily damaged. In the latter case connectors shall be so arranged as not to be exposed to accidental opening by persons handling the portable conductors or devices. Portable lamps in locations where explosives or inflammable gases are normally present shall be incased in vapor-proof globes with suitable mechanical guards.

(d) Portable and pendant conductors shall be so installed that no strain is placed on the terminal connections and shall have no joints except at suitable fittings.

(e) The use of worn or defective portable and pendant conductors should be avoided because of the danger to users by wire strands piercing the insulating covering, or becoming exposed through abrasion of the covering.

Electrically Operated Cars, Cranes, and Elevators

380. Guarding Live and Moving Parts

(a) All current-carrying parts connected to circuits above 150 volts to ground shall be so isolated or guarded that no person can inadvertently come in contact with them. (See rule 306 for trolley wires, etc.)

(b) *Conductors.*—All conductors over 150 volts to ground in locations accessible to the public shall be run in conduit, armored cable, or molding, the exposed metallic parts of which shall be permanently grounded.

(c) *Equipment.*—Guard for the current-carrying parts of unisolated electrical equipment, such as controllers, motors, transformers, automatic cut-outs, circuit-breakers, switches, and other devices, shall consist of cabinets, casings, or shields of permanently grounded metal or of substantial insulating material.

(d) *Arcing or Suddenly Moving Parts.*—All such parts of electrical equipment, including fuses and the handles and arc chutes of circuit-breakers, shall be so isolated or guarded that the liability of persons being struck or burned by sparking, flashing, or movement during operation is reduced as far as practicable.

381. Grounding Noncurrent-Carrying Parts

(a) All exposed noncurrent-carrying metal parts of electrical equipment at over 150 volts to ground shall be permanently grounded. In electric cars all steam or hot-water heating devices accessible to the public shall also be grounded.

The ground connection through well-bonded track rails will be considered satisfactory for equipment on cars and cranes.

(b) The metallic parts of portable cranes, derricks, hoists, and similar equipment on which wires, cables, chains, or other conducting objects are maintained should be provided with an effective protective ground (see sec. 9), where operated in the vicinity of supply lines operating at over 150 volts to ground, whether the cranes or similar equipment are themselves electrically operated or not.

382. Control of Energy Supply to Cars and Cranes

(a) Readily accessible means shall be provided whereby all conductors and equipment located in or on cars or cranes can be disconnected entirely from the source of energy at a point as near as possible to the trolley or other current collectors.

(b) A circuit-breaker or switch, capable of interrupting the circuit under heavy loads, shall be used unless the current collector can be safely removed, under heavy loads, from the trolley or third rail.

(c) Where a car is operated in locations other than private rights of way and equipped with both trolley and

third-rail current collectors, means shall be provided by which any exposed third-rail collector can be readily disconnected from the trolley circuit when not in use.

383. Control of Movement of Cars, Cranes, and Elevators

(a) Means shall be provided whereby the operator (whether motorman or elevator attendant) can prevent the starting of the equipment by unauthorized persons while he is absent from his post.

Removable reverse levers or controller handles and locked doors to the operator's cab are among the most effective means.

(b) The car-control lever of passenger elevators should be located so that the operator can readily face the principal car opening. For cars and traveling cranes the car control should be so located that the operator can readily face the direction of travel.

384. Subway and Car Lighting

Subways and similar locations used for passenger transportation where artificial illumination is indispensable shall be lighted throughout their entire length by a system independent of the current for electric traction where such is used. It is recommended that passenger cars operated in such locations and lighted normally by the current for electric traction shall be equipped with an auxiliary system of emergency lighting.

Telephone and Other Signal Apparatus on Circuits Exposed by Supply Lines

390. Guarding Noncurrent-Carrying Parts

(a) Where telephone or other signal apparatus (not included under *b* below) which must be handled by persons is permanently connected (not including portable telephones) to overhead signal circuits exposed by supply lines over 400 volts to ground, provision shall be made by one of the following methods against shock to persons handling apparatus:

(1) The use of suitable protective devices, including fuses and arresters.

(2) The grounding of all exposed noncurrent-carrying metal parts and the suitable guarding of all ungrounded current-carrying parts. (See rule 391.)

(3) The arrangement of apparatus in such a way that persons using it will be obliged to stand on a suitably insulated platform, in a suitably insulated booth or on other insulating surfaces. (The above applies only where apparatus is accessible to none but authorized persons.)

(4) The arrangement of apparatus (on signal circuits exposed to supply lines of more than 750 volts to ground) so as to have no exposed current-carrying parts exceeding 2 square inches in area with which a person is liable to come in contact and the use of suitable protective devices, including fuses and arresters or other means.

(b) Such signaling devices as fire- and police-alarm boxes and telegraph test boxes, if connected to overhead

signal circuits exposed by supply lines over 400 volts to ground, should have the accessible noncurrent-carrying metal parts permanently grounded wherever the character of service gives valid objection to the use of arresters or transformers on the signal circuit.

Police-alarm boxes where connected to overhead police-alarm circuits should usually be protected by arresters operating at 400 volts to ground, placed in the connecting leads outside the box.

Fire-alarm boxes connected to overhead circuits, if not protected by arresters, should be provided with suitable insulating material between the circuit within and the exposed frame and operating hook, this insulation to be capable of withstanding the highest voltage of the supply circuits to which the fire-alarm circuit is exposed up to 7500 volts.

391. Guarding Current-Carrying Parts

(a) Telephone or other signaling devices which are permanently located outdoors or where exposed to corrosive fumes or dampness (such as may occur in subways, cellars, basements, laundries, stables, etc.) shall be so arranged that all ungrounded current-carrying parts are so guarded as to be suitably protected against the prevailing atmospheric conditions.

The inclosing cases of signal apparatus provide suitable guards if substantially built of metal or insulating materials.

(b) Receiver cords shall be guarded by shields of permanently grounded metal (such as metal armor) or of nonabsorptive insulating material (such as flexible insulating tubing) or shall have suitable insulating coverings for the individual conductors.

(c) Where no protective device is installed (permissible only for fire alarm or similar apparatus or for apparatus not for public use, where the character of service precludes the use of arresters and fuses) the shields of portable cords shall always be of grounded metal or of special insulating material suitable to withstand the voltage of the highest supply circuit to which the signal circuit is exposed up to 7500 volts.

392. Protection Against Induced Voltages

(a) All telephone or other signaling equipment which must be handled by persons and which is connected to a line that parallels a supply circuit in such manner that by reason of exposure to the supply circuit under normal operating conditions more than 150 volts are induced between the terminals of the signaling equipment and ground shall be protected by one or more of the following means:

(1) All exposed metal parts of the equipment shall be insulated from the circuit, and the circuit shall be protected by arresters having a breakdown potential not exceeding one-half that of the insulation between the above-named noncurrent-carrying metal parts and the current-carrying parts.

(Continued on Page 493)

USE OF MEAN SEA LEVEL AS THE DATUM FOR ELEVATIONS*

THE term "engineering" is usually considered to be synonymous with the word "efficiency," but in at least one branch of engineering it is only partly true. This is in leveling.

There is scarcely any surveying or civil engineering which does not require that differences in elevation be determined by spirit leveling, and in nearly all cases the absolute elevation of the bench marks above some plane of reference or datum is determined. Efficiency in operation and in the results frequently depends upon the datum selected.

What is a satisfactory datum? This is a very important question and one to which much thought is directed by engineers. If one is grading streets or extending a sewerage or water system in a city, it is evident that the official city datum should be used in the leveling operations; but if a city is to adopt a surface for its datum, what should it be? Evidently it should adopt that datum which is most generally used by State engineering departments, by the railroads which enter it, and by other engineering organizations.

Then the State itself must consider what datum it should adopt, and its decision should be based upon the previous decision of other States adjoining it.

Finally, what datum should the nation adopt? It is evident that it would be impracticable for the nation, especially one of 3,000,000 square miles of area, as is the case in the United States, to adopt the surface thru some one bench mark as its datum in its early engineering work, for this would require that an elaborate system of levels should precede all its surveying and engineering operations.

Only slight consideration leads one to conclude that the ideal datum for a nation is one which may be established at many places. The only one of this kind is mean sea level.

Mean sea level is that surface which would be assumed by the surface of the water of the ocean if it were not disturbed by the attraction of the sun and moon and the force of the wind.

Mean sea level may be established within a very small fraction of a foot by continuous tidal observations for at least a year. It has been found from precise-leveling observations that mean sea level, as established at different points on the open coasts, is at all such points in the same equipotential surface; that is, if there were no resistance

of the water and wind to the movement of an object floating on the ocean the object could be moved from one point on the coast to another without performing any work—there would be no lifting necessary.

While this statement may not be absolutely true, yet it is so nearly the case that for all engineering and surveying purposes it may be accepted as rigidly true.

If we have a surface at hand which makes an ideal datum for the elevations of the country, should it be adopted? Efficiency demands that it should be.

Mean sea level is now used exclusively as the datum for all surveys on land by the Coast and Geodetic Survey and by the United States Geological Survey. It is only occasionally used by the Engineering Corps of the Army and not always by the Reclamation Service.

Usually the General Land Office does no leveling in connection with its surveys of the public lands. There is no other Federal organization which covers large areas in its surveying work.

We can scarcely say, in consideration of the evidence, that mean sea level has been universally adopted by the Federal Government as the datum for all of its elevations.

In December, 1916, the Coast and Geodetic Survey sent to the chief engineers of most of the large cities of the country, to the State engineer of each State, and to the chief engineer of each of about 150 railroads in the United States a circular letter asking for information regarding the use of mean-sea-level datum and whether the use of various arbitrary data by counties, cities, and private organizations within the States was a serious matter in the industrial development of the State.

The engineers of most of the cities reported that arbitrary data had been in use for many years. Many of them stated that it was generally realized that mean sea level should be used as the official datum, but that the expense incident to changing the many ordinances, profiles, plates, etc., made its adoption of doubtful expediency.

In all cases except one, the State engineers informed the Bureau that mean sea level was used as the datum for the State work wherever bench marks were available whose elevations were based on this datum. They strongly advocated the rapid extension of the precise-leveling system of the country in order that no extensive engineering and surveying should have to be based upon assumed elevations or arbitrary data.

The chief engineers of many of the railroads replied that mean sea level was used, or was in process of adoption, by their roads. The general expression of opinion was that the precise-leveling net of the country should be

* Extracted from Special Publication No. 41, U. S. Coast and Geodetic Survey. Written by E. Lester Jones, Superintendent.

ENGINEERS' CLUB OF PHILADELPHIA

completed or greatly extended in order that the accurate elevations might be at hand as the base for what might be termed the "detailed leveling."

Instances were cited where a road had apparently been on sea-level datum, but considerable error had been disclosed after the precise leveling had been extended to its lines. Such instances as these show that mean-sea-level elevations in areas far from the coasts, if not based upon precise levels, may be in error to such an extent that for practical purposes they may be considered as being based upon arbitrary data.

A special committee on datum planes of the Municipal Engineers of the City of New York, 1916, prepared a chart showing a comparison of the various datum planes in use in the city of New York.

It is evident that in the city of New York there must be much confusion resulting from the use of so many data, and it is possible that the confusion in the elevations and the data may involve the city in much extra expense on engineering work, due to errors which must inevitably be made in interpreting the leveling data.

Conditions in the city of Cincinnati in regard to elevations were so unsatisfactory that, in August, 1913, the council of that city adopted by ordinance mean sea level as the official datum for all city surveying and engineering operations. Before the adoption of this datum each of the various sections of Cincinnati which had been an independent town had its own datum for levels, and there

The different sea-level datum lines used in Salt Lake City, the city's datum being the lowest and rated as zero, are:

	Feet
Salt Lake City Corporation	0.00
United States Weather Bureau.....	23.28
Oregon Short Line Railroad.....	} 26.95
United States Coast and Geodetic Survey	
Denver and Rio Grande Railroad.....	28.42

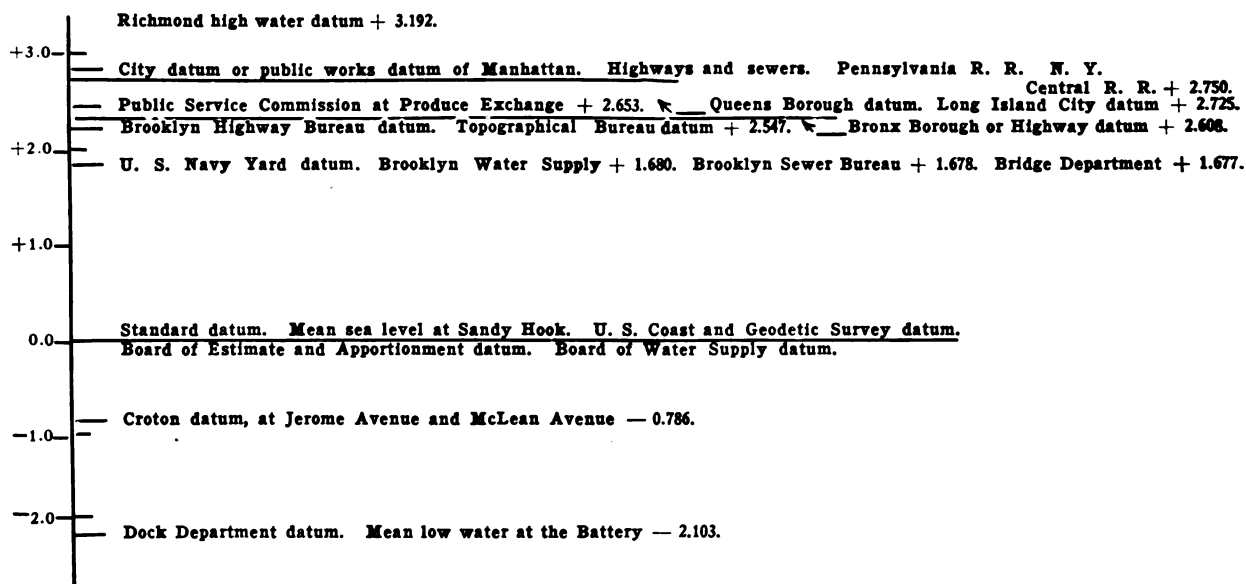
In Pennsylvania all the district engineers use mean sea level as the datum for their elevations, and reports indicate that the majority of the city engineers also use mean sea level, but that the cities of York, Philadelphia, and Pittsburgh use arbitrary data.

In Oregon, in connection with the State's irrigation and highway work, are based, wherever possible, the surveys on mean-sea-level datum. The bench marks of the United States Coast and Geodetic Survey and the United States Geological Survey are of great benefit, as all surveys based upon them are on the same datum, and when connected form a uniform network over the State.

This is a very important point, for it is where new surveys must be connected with other surveys that great confusion arises unless all are based upon the single datum for elevations. If there were to be only one survey in a restricted area, and that survey would never have to be

THE MUNICIPAL ENGINEERS OF THE CITY OF NEW YORK

COMPARISON OF DATUM PLANES



was no official connection of the various systems of elevations.

That it is necessary to have precise leveling extended into areas where such control is not now available is clearly indicated by the data furnished by Salt Lake City. The only elevations available in Utah previous to about fifteen years ago were from leveling by railroads, and that leveling was done for the immediate control of railroad construction rather than to carry absolute values with great accuracy.

joined to any others, it would be a matter of indifference as to whether one datum or another were used for elevations.

The engineering department of the State of New York has, since 1898, used mean sea level in all of its work. Previous to that time, elevations were upon a different datum for each of the three divisions of the New York State canals, those divisions having their headquarters at Albany, Syracuse, and Rochester.

The various railroads of the country are vitally inter-

MEAN SEA LEVEL AS DATUM FOR ELEVATIONS

ested in the adoption of mean sea level as the sole datum for elevations in the country, for each of a number of railroads traverses the territory of several States and of innumerable cities and towns. There is necessarily a great deal of confusion in elevations between the railroads and the various municipalities and political units thru which the roads pass if each unit has its own datum.

The Interstate Commerce Commission directed the various railroads of the country to show on their profiles the equations necessary to reduce elevations to sea-level datum or to have the profiles based upon mean sea level. This was for the valuation work undertaken by the commission. The result of this requirement has been that many railroads changed from arbitrary data to the mean sea-level datum, although probably most of the roads of the country had previously adopted mean sea level as their datum. It may be interesting to note that the Board of Railway Commissioners of Canada has directed the railroads of the Dominion to submit all information in connection with elevations and profiles on mean-sea-level datum.

Statements from many of the most prominent engineers of the country prove conclusively that it would be far better for the country in its industrial and engineering developments if there were used only one datum, and if that datum were mean sea level. It is realized by the members of the Coast and Geodetic Survey that much of the confusion in data which now exists is due to the fact that the precise-level net of the United States was not extended in the past as rapidly as it should have been. It, of course, was impossible, or rather impracticable, to extend a precise-level net into areas thru which railroads had not been run, for the expense would have been prohibitive. It may be that the Survey did not fully realize the necessity for having all engineering and surveying work on the same datum, but in recent years it has been fully alive to the necessity of having a single datum for the entire country, and it is consequently extending its precise-leveling net as rapidly as funds available will permit.

To show how active the Survey has been in its precise leveling in recent years, it may be stated that in December, 1907, there were in the United States 24,000 miles of precise leveling which had been run by the United States Coast and Geodetic Survey, the Corps of Engineers, United States Army, the United States Geological Survey, the United States Lake Survey, the Pennsylvania and the Baltimore and Ohio Railroads, together with the Mississippi and Missouri River Commissions. The amount of precise leveling in the country in December, 1916, was 35,500 miles. It may be interesting to note that during the calendar year 1916 about 2500 miles of precise leveling were added to the net by the Coast and Geodetic Survey.

That the amount of precise leveling in the United States is entirely inadequate is shown in the following table which gives the amount of leveling in many of the countries of the world. This table also shows the amount of such leveling for each 100 square miles of area.

PRECISE LEVELING IN A NUMBER OF COUNTRIES

Country	Area	Miles of precise leveling	Miles of precise leveling per 100 square miles of area
United States	2,970,000	35,500	1.2
Alaska	591,000	20	.0
British Isles	121,000	12,804	10.6
Austria-Hungary .	241,000	13,129	5.4
France	207,000	7,284	3.5
Germany	209,000	33,651	16.0
Italy	111,000	4,603	4.2
Japan	176,000	9,129	5.2
India	1,767,000	17,301	1.0

The Survey, whose obligation it is to extend the precise-leveling net over the country for the use of Federal, State, city, and other engineering, surveying, and mapping work, feels that the expressions of opinion of the leading engineers of the country point to only one conclusion. This is that the Federal Government should provide the fundamental elevations in sufficient number that the various Federal engineering and surveying organizations and the smaller political units, such as States, counties, and cities, as well as private organizations and individuals, may have available fundamental elevations upon which to start leveling, precise or otherwise, for detailed operations.

The amount of precise leveling which should be done by the Federal Government cannot be foretold. It must depend upon the needs of the various organizations and individuals using the results. After a certain development of the precise-level net which appears now to be absolutely necessary, the rapidity with which further extensions are made should depend upon the development of the country. But such further extensions should precede rather than follow such development, as is proved by the unfortunate condition of affairs in much of our engineering and surveying work, due to lack of precise elevations in the past, when such work was inaugurated.

With the increased demands for accurate topographic maps of the country, the wonderful extension of our good-roads movement, the extension of the railroads, and the development of river, irrigation, and drainage projects, the precise leveling of the country should be carried in the near future into many of the large areas now having little or no accurate leveling. The further conclusion may be drawn that it will be best for the efficiency of the country as a whole that all new leveling, by the various organizations and individuals engaged upon engineering and surveying work, be placed upon mean-sea-level datum, wherever this is practicable, and also that as far as possible existing leveling referred to arbitrary data should be changed to sea-level datum.

It is hoped that as a step toward the industrial preparedness of our nation the engineering press, the national, State, and city engineering societies and associations, and engineering organizations and individuals of the country will take an active part in furthering the use of mean sea level as the datum for elevations.

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EDITORIAL

FOR many engineers who are engaged in making reports on projects there is a tendency, of late years increasing, to present too great an elaboration of unessential information. Many times clients paying for a report desire a very simple statement as to whether the project is feasible or not feasible, and often engineers with the greatest experience will present such a report in very brief but entirely sufficient manner, occupying probably not more than five or ten pages of typewritten matter. Others find it necessary to complicate a simple matter by hundreds of pages of main data, appendices, maps, etc., without adding anything to the value of the simple conclusion in the report. This tendency is due to court practice.

An architect may be called upon to testify concerning the cost of a certain building. If he be a man of broad experience in this line his off-hand statement is more likely to be nearer the truth than the result of days of calculation by those of less experience. Still, if he has to testify in court, he is supposed to fortify himself with all the necessary supporting detailed data.

In the valuation of half a dozen important water-works the engineering reports made within the last four years in Pennsylvania with a view to presentation before the Public Service Commission have cost several hundred thousand dollars, altho results of equal reliability, with the unessentials eliminated, could have been furnished and obtained for one-tenth the cost. This unnecessary detailed work was done, no doubt, for the purpose of impressing the courts and commissions with the accuracy and exhaustiveness of the presentation; but there are some subjects in which the accuracy and usefulness are not improved by intricate calculations or multitudinous detail.

This is illustrated by a very simple phenomenon: A billiard player makes an all-around-the-table shot. This is a perfectly scientific and theoretical problem capable of exact mathematical solution, but the necessary calculations would involve hours of expert mathematical application—the intensity of the blow, the exact amount of “*English*” required so that after making the shot the object ball and the other two will be in proper relative positions for a second shot, the necessary allowance for friction, etc., are all involved. The player, however, applies the results of his years of practice and, in a moment, instinctively solves the problem by a brilliant and masterly stroke. Exactly the same result can be obtained in many engineering problems.

The engineer is asked, What is the cost of a horizontal return tubular boiler erected complete and set up with brick-work? If he has had large experience in this line,

he has two courses open—he may calculate the weight of the boiler, the number and character of rivets, the thickness of shells and heads, weight of tubes, fabrication, labor, transportation, overhead costs, etc., and in the same manner the cost of brick-work, fronts, and fixtures, and spend several days, if necessary, or he may give the cost off-hand. The latter figure will probably be more nearly correct than the result of his elaborate detailed calculation, but in one case the cost of obtaining the result is enormous compared with the other.

The case is illustrated by an episode that recently occurred in Philadelphia: The head of one of the city departments had occasion to call in an arbitrator on a very troublesome controversy that had been pending for months. This arbitrator succeeded in agreeing in half a day with the one appointed by the other side. On being questioned as to the bill for services, the arbitrator stated, “The work involved only one day’s time,” but the Chief, being a broad-gauge man, said, “No, it required thirty years’ experience to handle the matter so expeditiously.” And so it is with the engineer’s judgment. His best conclusions are the result of all his past training, and should not be measured by the square yard of plan or ream of report.

Of course, in many cases the problem is such that it is necessary to go into great detail, because there may be no other way of arriving at a solution. But in a known exaggerated case, in which an engineering firm was asked to make a report on a project, that could have been as well completed in twenty-four hours as if a year had been spent upon it, because the problem, as well as the report, were thoroly known in advance, this firm spent several months preparing a handsome volume of elaborate data, and charged their clients an enormous fee, all perfectly legal and not uncommon, but not what might be called high-toned engineering.

There is a certain amount of character and ability required in preparing a full, handsomely appearing, and fairly well-written report on an engineering project. The chances are, however, that those who want the report do not want it for its literary value, but for the vital engineering conclusions contained therein. The literary features usually are within the capacity of an easy writer, while the engineering conclusions require the result of years of preliminary education and many other years of practical experience.

The engineer who is brilliantly resourceful and capable of evolving vital ideas is not generally contented

(Continued on Page 496)

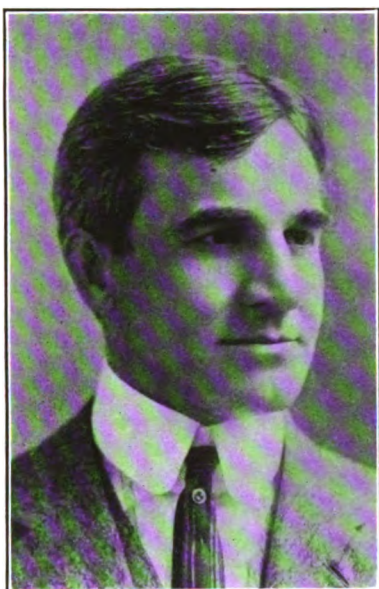
COMMITTEE ON PAPERS

LEWIS H. KENNEY, CHAIRMAN

ANNOUNCEMENT

Joint Meeting of Engineers' Club of Philadelphia and the Philadelphia Section of the American Society of Mechanical Engineers
TUESDAY, 8.15 P.M., OCTOBER 16, 1917, AT WITHERSPOON HALL.

THE paper of the evening, "**The War's Effect on Merchant Shipbuilding**," will be presented by **Mr. Homer L. Ferguson**, President and General Manager of Newport News Shipbuilding and Dry Dock Company.



An abstract of Mr. Ferguson's paper appears on page 483.
Members of Affiliated Societies are cordially invited to attend.
Members of the Club and Affiliated Societies are privileged to invite ladies.

MEETINGS FOR JUNIOR MEMBERS

Dr. W. M. Boehm, member of the Committee, has been elected Chairman of the meetings. Attendance at the meetings will be limited to Junior Members and their guests, and Officers and Senior Members invited by the Committee on Papers.

October 9, 1917—*Meeting at The Engineers' Club.* The meeting will be addressed by several Senior Members of the Club.

Rules governing award of the Junior Prize were published on Page 380 of the August PROCEEDINGS.

ABSTRACT OF PAPER

"THE WAR'S EFFECT ON MERCHANT SHIPBUILDING"

To be presented by **Mr. Homer L. Ferguson** at Joint Meeting of Engineers' Club of Philadelphia, and Philadelphia Section of the American Society of Mechanical Engineers, October 16, 1917.

THE submarine campaign of the Germans has rendered it imperative that present merchant ships in existence be furnished a more adequate protection and also that ships lost be replaced at an unprecedented rate by new construction.

The large number of sinkings of steel vessels has probably abolished forever the 8-, 9-, and 10-knot vessels in transoceanic trade.

The military requirements for shipping troops and supplies have made enormous demands for high-speed passenger transport vessels, which demands, so far, have been fairly well filled by British ships, but there are probably not enough available transport ships for the United States to carry to Europe more than 750,000 soldiers per annum. This growing demand for large, high-speed vessels is becoming more insistent and is bound to result in the construction of vessels of this kind.

The demand for slower freight vessels is being met in part by the construction of so-called *standardized* types abroad and by the construction of additional ships of the "fabricated" designs in this country and by the attempted construction of wooden vessels.

The center of the fabricated steel ship industry will be Philadelphia, thus emphasizing the fact that the Delaware is rapidly becoming the first shipbuilding river in the world. Fortunately for the Delaware, few wooden ships are to be built here. The wooden shipbuilding program is destined to be one of the greatest disappointments of the war, and, not being an expert in building wooden ships and not being acquainted with them, it does not seem necessary to elaborate on this theme.

The standardized ship has been the dream of shipbuilding architects and engineers ever since the first steel ship was built. The best results, up to the present time, have been obtained by the yards on the Great Lakes in building ore ships for a given fixed trade with practically standard loading and unloading facilities. The standard ship has also been developed to a certain extent by individual merchant yards in Great Britain. All of the shipyards have naturally, in the course of years, built up standard methods of doing certain things, such as standard fittings, valves, flanges, drop forgings, deck and engine-room fittings of all kinds, but, except for the Great Lakes, the yards have not been able to adopt standard hulls, which is the main essential difference between the proposed new vessels being built for the Government under a most urgent necessity and vessels built heretofore to the individual taste and requirements of scattered owners.

The designs of these "fabricated" vessels are such as to permit of the use of the most modern shop methods in preparing the material in order that the minimum amount of work may remain to be done in the assembling and launching yards, but, no matter what the type of vessel to be constructed, the crux of the shipbuilding question lies in the amount of labor that may be made available for this building. Steel material, of course, is a most important factor, but there is no doubt in the minds of the men best able to judge, that the steel output of shipbuilding steel material is, at present, far ahead of the shipbuilding capacity. If our shipbuilding program is to have any reasonable assurance of success it is necessary that the output on this coast, for instance, be doubled within the next twelve months.

As men skilled in shipbuilding are not available, and as shipbuilding communities are now crowded to the doors for housing accommodations, it seems fairly clear that the problem narrows down to the question of breaking into shipbuilding men from the interior, in large part, and of providing these men with suitable housing facilities.

At present there are employed in the shipyards on the Delaware and on Chesapeake Bay and tributaries about 32,000 men. These shipyards are planning improvements which, when completed, in about one year, will provide for 58,000 men. Their present capacity, as a matter of fact, would employ 46,000 men if they could get them.

The new shipyards contemplated for "fabricated" ships in this district will require from 20,000 to 25,000 additional men. The extraordinarily high wages being paid at the present time have unfortunately resulted in a decreased production, due to a poorer attendance. That is the experience of practically all shipyard managers at this time. If the war is to be won by ships, or, to put it in another way, if of all the elements entering into the winning of the war the production of sufficient ships to win the war is the one element for which no satisfactory solution has yet been offered, does not shipbuilding assume a newer significance, and is it not time that it should be considered not only an act of patriotism but a binding duty upon every man engaged in shipbuilding to remain in that service continuously?

The drafting of men for the work of shipbuilding, in one form or another, will probably become necessary, and it is to be hoped that the necessity of meeting this question in time will become apparent before our soldiers in France need either food or munitions.

CLUB HOUSE IMPROVEMENTS

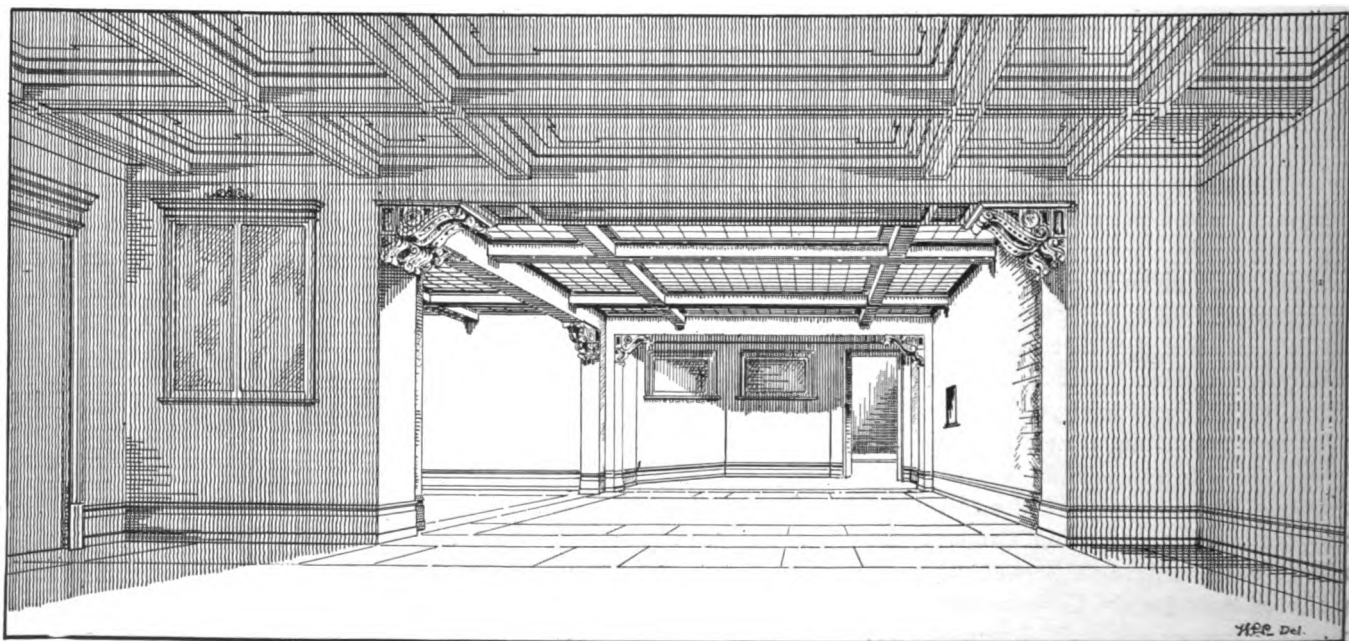
THE Building Committee wishes to announce that the detailed plans and specifications for the contemplated enlargement of the Club's facilities have been posted in the Club House for constructive criticism of the membership-at-large for the past three weeks, and, no adverse criticism having been received, it feels justified in taking it for granted that the membership is thoroly satisfied with the proposed arrangements, and that everything possible is being done to expedite the work of actual building.

The Engineer, above all others in the community, is aware that much time is consumed in arranging the preliminaries that must always precede the execution of his plans, in that he may be ready to meet inevitable conditions as are bound to arise should he neglect to anticipate possible delays, and provide some logical form of procedure in the event that a hold-up does occur.

Conditions of labor, materials, and deliveries are far from normal. The Committee therefore found it necessary to investigate market conditions and modify its plans so as to accommodate them to the situation, and to formulate a schedule definite enough to warrant proceeding. From bids from various sub-contractors it has

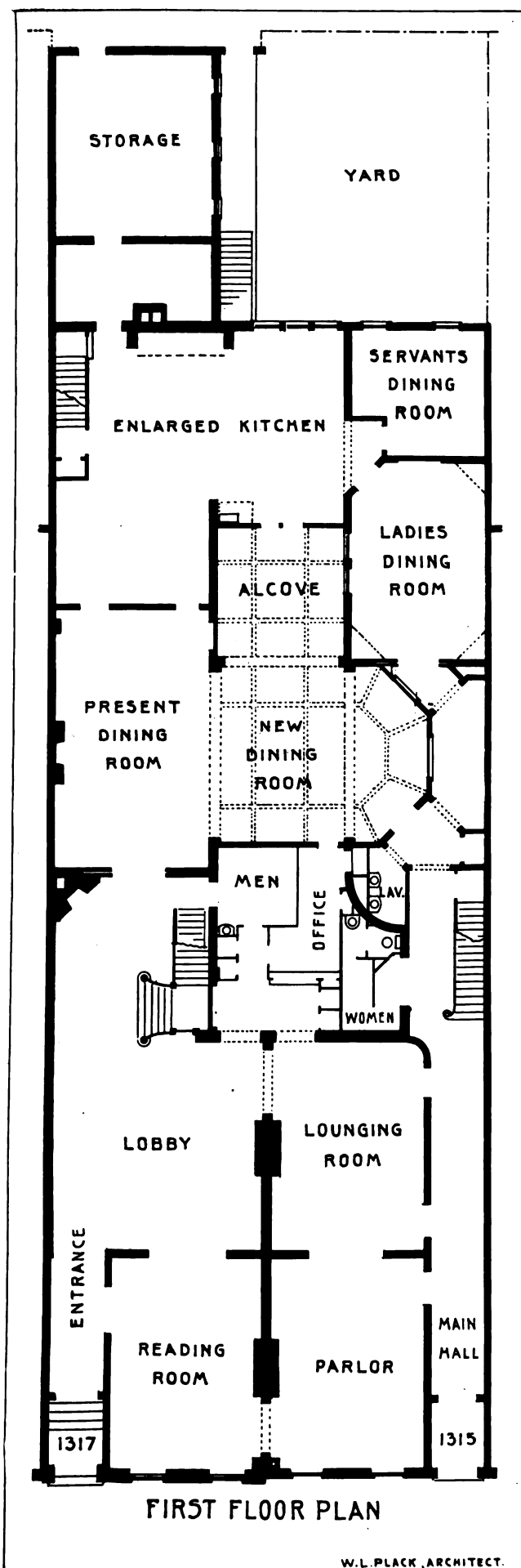
at command practically all the essential materials needed, except the steel girder intended to carry the upper floors over the proposed new auditorium. The uncertainty of delivery of this girder may postpone the enlargement of the auditorium for an indefinite period. The Committee fully realizes that an enlarged auditorium is regarded by a vast majority of the members as the important feature made possible in the acquirement of the adjoining property, and, while this opinion was partially expressed in generous subscriptions to the Building Fund, it is now self-evident that the money available for improvements, if applied to the strictly economic emergencies of Club welfare, will give a large measure of real comfort in the shortest period of time. Increased auditorium facilities can temporarily be had outside of the Club House, but the additions and improvements to the Club House proper, other than the new auditorium, seem, in the Committee's judgment, matters of the utmost importance.

The problem for solution just now is to provide even the absolute necessities within the amount of money available. It has been decided, therefore, to subdivide the work into four separate and distinct propositions. The plans and specifications have been so drawn that each



INTERIOR PERSPECTIVE OF THE NEW DINING-ROOM

CLUB HOUSE IMPROVEMENTS



one may be contracted for and carried to completion in successive order as the money becomes available.

At a special meeting held September 24 the Board of Directors approved the plans and specifications for the alterations as presented by the Building Committee, and the Committee was authorized to proceed with the work as outlined in the proposition above.

The first proposition is the installation of a new steam-heating boiler of double the capacity of the present one, so that the present quarters may be heated during the process of construction on the addition.

The second in importance is that the entire first floor shall be made ready for use as soon as possible to rush the work to completion. This will provide dining space for one hundred persons at one sitting. The portion reserved for ladies is sufficiently isolated for formal privacy at all times. An enlarged kitchen, extending east fourteen feet and north twenty-two feet, the latter addition being for the storage of supplies and for the installation of a modern refrigerating plant. The cellar will hold approximately sixty tons of coal.

The first-floor plan clearly illustrates the material enlargements and their relative utility relations.

The questions of light and air have been provided for. The air will be renewed every fifteen minutes by a noiseless fan at the terminus of a properly designed series of internal conduits. The daylight illumination of the dining-rooms, kitchen extension, office and cloak-rooms, etc., is provided by making the entire deck roof inserted between the two rear buildings at an elevation of one story, eighty-two per cent. transparent by the use of Tanex glass set in cement, supported upon steel beams and enclosed in concrete. Under this vault lighting regular wood-paneled ceilings will support diffusing sash, of various ornate glasses in some geometric pattern.

One point, particularly, that should be given serious consideration by the membership, and on which the Committee had specially solicited expressions of opinion, was on the ceiling height of the new auditorium. This will be approximately the same as the present auditorium, which is not as high as is desired. However, advantage has been taken of the slight difference of floor elevations between the two houses, with the result that the auditorium floor descends in the direction of the rostrum.

Propositions three and four are not sufficiently complete to be described at this time.

S. M. SWAAB, *Chairman,*
Building Committee.

GEORGE S. CHEYNEY

1863-1917

GEORGE S. CHEYNEY, who was a member of the Engineers' Club since 1885, died at the home of his mother, at Cheyney, a village named after the family and located on the Philadelphia and West Chester branch of the P., B. & W. R. R.

Mr. Cheyney, who lived at the Engineers' Club, had, according to his frequent custom, gone out to spend the evening and night at his mother's home. He had been apparently in normal health, but his mother, being surprised at his delay in coming to breakfast, went to his room and found him lying on the bed, almost fully dressed, dead. Their physician said it was one of those baffling cases of heart-failure, because he had been examined only a short time before, and his heart was found to be in good condition.

Mr. Cheyney was born July 5, 1863, at Cheyney, Pa. His boyhood days were normal and happy. He loved the out-doors and the regular boyish sports, scraps, and pranks. He had notions of his own of how a boy should spend his days, and fishing, gunning, and baseball occupied a more important part of his curriculum than the three R's, or the more prosy Sabbath observances. Nevertheless, his standard of honesty and dependableness was always high, and he grew up naturally, without mannerism, pretension, or hypocrisy.

While naturally of studious and investigating nature, he did not exercise these traits markedly until he left the influence of the public schools, whose particular methods must have been distasteful to him.

He left school at about sixteen and entered the office of Alfred D. Sharpless, auditor of the old West Chester and Philadelphia Railroad Company, where he spent two years. He then had some additional office experience in Philadelphia, lasting only a few months, when he began his engineering training proper, working for Clemson Sharpless, of West Chester, who was engaged in surveying a proposed railroad between Philadelphia and West Chester, *via* Newton Square. This work was of short duration. The company ran out of money and consequently Mr. Cheyney never was paid for his first engineering work. However, his interest was aroused, and from that time on he applied himself with avidity to the study of engineering. He, no doubt, would have gone to some engineering college, but concluded that the methods would be a replica of those impracticable ones that so disgusted him in the public schools, and concluded he could make better progress studying the things he considered essential by the method he believed to be the most efficient.

In the early sixties he became engaged on hydrographic and topographic work in connection with the water supply studies which were then being made by Rudolph Hering for Philadelphia. Various water-sheds were examined, including the Delaware, Schuylkill, and, more particularly, the Tohickon, Neshaminy, and Perki-

omen creeks. When this work was completed, after two or three years, he went West and was employed under Mr. Ainsworth, Chief Engineer of the Old Freemont, Elkhorn and Missouri Valley Railroad, now a part of the Northwestern System. Various lines were projected and some constructed, one of which went into the Black Hills, Dakota.

He was then placed in charge of a line being constructed by the Freemont, Elkhorn and Missouri Valley Railroad, after which he took a contract for the United States Government to make a topographical survey in the Bad Lands of Dakota. During these times he and his party had some exciting experiences with the Sioux Indians.

About 1892 he became resident engineer of the Williamsport and North Branch Railroad, which was extending its lines to Satterfield, where he remained about three years. He then became roadmaster and claim agent of the Indianapolis, Decatur and Western Railroad, remaining about two years.

In 1901 Mr. Cheyney did what many engineers do sooner or later—tried his hand at contracting. His first job of importance was the construction of a reservoir for the Elwyn Training School, the writer being engineer. During this construction the writer was so thoroly impressed with his honor, reliability, and the earnestness with which he looked after this piece of work, a year later he was offered a position with the American Pipe and Construction Company. After a year or two of work, in which he was in charge of construction of important reservoirs and other work, he was made Principal Assistant Engineer, and from 1903 until 1910 he was intimately engaged with the writer in making preliminary investigations, reports, plans, surveys, and other work in connection with the installation of the water-works for the supply of the Pennsylvania Railroad—the largest water system for railroad purposes ever constructed. This work involved some 500 miles of large pipe lines and 40-odd dams and reservoirs, steam and water-power pumping stations, the organization of scores of water companies, the purchase of water-sheds and water rights, and almost every problem that occurs in water-works practice. So efficient were Mr. Cheyney's services in this connection that when the works were finally completed and put in successful operation Mr. Cheyney was the logical man to be continued in responsible charge of this enormous system.

From 1910 to the time of his death he devoted his time continuously with heart and soul in his work, and practically lived with it night and day.

As an engineer, Mr. Cheyney was earnestly devoted to his duties, and was never known to shirk, however

(Continued on Page 494)

SECRETARY'S NOTICES

A JOINT MEETING of the Engineers' Club and the Philadelphia Section of the American Society of Mechanical Engineers will be held **Tuesday evening, October 16, 1917**, at 8.15 o'clock, at **Witherspoon Hall**.

Mr. Homer L. Ferguson, President of the Newport News Shipbuilding and Dry Dock Company, will address the meeting on "**The War's Effect on Merchant Shipbuilding.**"

Members of Affiliated Societies are extended a cordial invitation to attend this meeting.

Ladies are welcome.

H. A. STOCKLY, *Secretary*.

ABSTRACT OF MINUTES OF REGULAR MEETING OF ENGINEERS' CLUB

SEPTEMBER 18, 1917

The meeting was called to order by Mr. Lewis H. Kenney, Director-at-large, at 8.20 P.M. About 200 members and guests were in attendance.

The minutes of the Regular Meeting of June 19 were approved as printed in the PROCEEDINGS.

Announcement was made of the National Meeting of the American Institute of Electrical Engineers, to be held October 8, at the Bellevue-Stratford, and also of the Joint Meeting of the Engineers' Club with the American Society of Mechanical Engineers on October 16, at Witherspoon Hall.

Motion pictures, "The King of the Rails," loaned by the General Electric Company, were shown.

The meeting adjourned at 9.15 P.M.

H. A. STOCKLY,
Secretary.

ABSTRACT OF THE MINUTES OF REGULAR MEETING OF THE BOARD OF DIRECTORS

SEPTEMBER 11, 1917

The meeting was called to order at 7.45 P.M., with President Vogleson, Vice-President Eglin, Directors Henderson, J. C. Wagner, Kenney, Hayward, Moody, S. T. Wagner, Forstall, Past Presidents Swaab and Ledoux, Treasurer Jones, and Secretary Stockly in attendance. Vice-President Yarnall, Directors Fernald, Ehle, George W. Barr, and Past President Carter were excused. Vice-President Andrews, Directors Bullens and Robert M. Barr were absent.

The minutes of the Regular Meeting of June 12 and the Organization Meeting of June 19, as submitted to the Board of Directors, were approved. The minutes of the Executive Committee meeting of August 14 were approved as read.

REPORT OF THE PRESIDENT

Announcement of the following committee appointments was made:

The personnel of the Committee on House is as follows:

H. P. Gant, Chairman	Wm. Pool Parker
Robert M. Barr	Edward F. Cobb
M. M. Price	

Dr. W. M. Boehm has been appointed a member of the Committee on Increase of Membership.

Mr. Walter E. Long has been appointed a member of the Committee on Finance.

The following have been appointed to serve on the Building Committee for the present year:

S. M. Swaab, Chairman	F. C. Dunlap
H. P. Gant	Wm. Pool Parker
J. F. Murray	H. A. Stockly (<i>ex officio</i>)

The following have been appointed to serve on the National Service Committee for the present year:

Guilliaem Aertsen, Chairman	Wm. C. L. Eglin
Lewis H. Kenney	S. M. Swaab

(Fifth member to be appointed)

REPORT OF THE SECRETARY

Mr. N. A. White has been elected secretary of the Technology Club of Philadelphia, and associate editor on the PROCEEDINGS, representing the Technology Club, vice Mr. G. W. Barnwell, resigned.

The report on the Campaign for Building and Equipment Fund was read and accepted.

A letter from Mr. Swaab, on the subject of insurance for the benefit of families of Club members who may suffer fatality while in service, was read.

Action: Letter referred to the Committee on National Service.

A number of members have resigned recently, due to the fact that they expect to be away indefinitely in war service for the Government. There have also been a few requests for special action by the Board in remitting the dues of members in Government service.

ENGINEERS' CLUB OF PHILADELPHIA

Action: That the dues of any member of the Club who is in active service in the Army or Navy be automatically remitted while he is in service, during the duration of the war; and that those members in the service who have tendered their resignations, or requested remission of their dues, be notified of this action of the Board.

Resignations from the following were read and accepted:

W. R. Shively
Percy L. Neel

Mr. Wilbert C. Cornell, who resigned from Junior membership May 8, 1917, requests reinstatement. It is recommended that the Board reinstate Mr. Cornell as of April 1, 1917.

Action: Recommendation approved.

The following deaths are announced:

G. W. Creighton. Active Member. June 2, 1917
F. E. Bailey. Active Member
G. S. Cheyney. Active member. August 17, 1917

The Committee on Publication has requested a biography of Mr. Cheyney for publication in the PROCEEDINGS.

REPORT OF THE TREASURER

The Treasurer presented a report, which was accepted. He also announced that the quarterly audit of the Club books, to July 31, 1917, had been completed.

REPORT OF THE COMMITTEE ON FINANCE

The Chairman submitted a report on the finances of the Club, which was accepted.

It was ordered that the matter of the Club's prospective income for the coming year be looked into, report to be made to the Board.

REPORT OF THE COMMITTEE ON HOUSE

A report from the Chairman was read and accepted.

REPORT OF THE COMMITTEE ON PUBLICATION

The Chairman presented a report, which was read and accepted.

A report was also presented recommending that the name of the Club publication be changed from "The Proceedings of The Engineers' Club of Philadelphia" to "The Journal of The Engineers' Club of Philadelphia," effective beginning with the October issue.

Action: Recommendation approved.

REPORT OF THE COMMITTEE ON PAPERS

The Chairman presented a letter addressed to the Board of Directors, signed by a Committee of Juniors, which had been referred to the Committee. In this letter the Juniors requested that they be permitted to form an organization which would bear a somewhat similar relation to the Club as that established for affiliated societies; that they select their own chairman, Executive Committee, and Papers Committee.

It was suggested that Dr. W. M. Boehm, who was chairman of the Junior meetings last year, continue as

chairman *ex officio*, and as a member of Junior Committees, *ex officio*.

The Committee recommended that no definite organization of the Juniors be established at this time, but that Dr. Boehm, who had been appointed by the Committee as chairman of the Junior meetings, be authorized to appoint from among the Juniors a committee to assist in developing the schedule of papers and other committees as he found desirable.

Action: Report accepted and recommendations approved.

Announcement that the Junior Prize will be awarded next year, together with the rules governing the award, were published in the August issue of the PROCEEDINGS.

The Club meetings have been arranged up to and including the January meeting at Witherspoon Hall, due to the fact that no definite information was at hand as to when the modifications to the Club auditorium would be completed.

Action: Report accepted.

REPORT OF THE COMMITTEE ON MEETINGS

The Committee reported that at a recent meeting ways and means of developing the affiliation idea were considered, the subjects discussed being as follows:

First, coöperation in developing the schedules of papers. This subject is in process of development.

Second, joint meetings with the Engineers' Club and Affiliated Societies. The following joint meetings were arranged:

October 16 A. S. M. E.
November 20 W. T. C.
December 19 A. I. E. E.
January 16 A. S. C. E.

Third, joint meetings between Affiliated Societies. This subject is in process of development.

Fourth, feasibility of making arrangements for publishing in the PROCEEDINGS papers presented before the Affiliated Societies. In order to continue our PROCEEDINGS in its present size, the papers provided by the Committee on Papers, the notices of officers and committees of the Club, and the notices of Affiliated Societies must be augmented by other subject matter. The members stated that they would refer to their respective Affiliated Society the subject of publishing in the PROCEEDINGS papers presented before their meetings, and report at a later meeting of the Committee. If this can be accomplished, it will provide for an exchange of technical information between the Club and the Affiliated Societies, and increase the value of the PROCEEDINGS.

Fifth, publishing in the PROCEEDINGS carefully prepared notices of all meetings of the Club and Affiliated Societies. This subject is in process of development.

Action: Report accepted.

SECRETARY'S NOTICES

REPORT OF SPECIAL COMMITTEES

The Committee on Increase of Affiliated Societies

The Committee reported that three organizations were being solicited for affiliation—the local sections of the American Chemical Society, the National Safety Council, and the American Institute of Architects.

Action: The Secretary was instructed to arrange, thru Dr. Hering, a luncheon for the Board of Directors and representatives of the Chemical Society.

BUILDING COMMITTEE

The Chairman stated that a meeting had been called for Thursday, September 13, at which time the entire subject of alterations to the property at 1315 Spruce Street would be considered, report to be made to the Board at its next meeting.

Action: The Committee was requested to prepare plans and obtain bids on the work of alteration, and to report its results to the Board.

NEW BUSINESS

Mr. Wagner called attention to the fact that only about one-half of the membership was personally solicited for subscriptions to the Building and Equipment Fund, and suggested that steps be taken towards obtaining subscriptions from those members so far unsolicited.

Action: The President was authorized to appoint a committee to arrange for a continuation of securing funds for Building and Equipment.

The meeting adjourned at 10.17 P.M.

H. A. STOCKLY,
Secretary.

SUPPLEMENTARY LIST OF SUBSCRIBERS TO BUILDING AND EQUIPMENT FUND

FROM AUGUST 24 TO SEPTEMBER 24, 1917.

(Originally published on Page 428, September PROCEEDINGS.)

American Dredging Company	*John P. Flood	*Nathan Hayward	*J. Chas. Redmond
Crew Levick Company	*Wm. Forsyth	*John J. L. Houston	*Howard C. Roeder
*Geo. H. Doxrud	*Chas. F. Gross	*Edward S. Hutchinson	*Philip Weiss
A. L. Drum	*Geo. A. Gumphert	*W. T. Kershaw	J. G. White Eng. Corp.
J. J. Fitzgerald Co.	*P. Hall	*James T. Maxwell	

* Indicates a member of the Engineers' Club of Philadelphia.

SPECIAL NOTICES

On Thursday, September 6, a conference was held in The Engineers' Club between Dr. Carl Hering, who is chairman of the Committee on Increase of Affiliated Societies, and the officials of the Philadelphia Safety Council.

A movement is under way for the affiliation of the Safety Council with The Engineers' Club. A number of men in this association are also members of The Engineers' Club. The Local Council is affiliated with the National Safety Council, whose work in the dissemination of safety literature is very well known.

There are in Philadelphia and vicinity about 240 members.

Meetings are held monthly during the winter season.

The officers of the Council are as follows:

M. M. Sheedy, Pennsylvania Manufacturers' Association Casualty Insurance Company, president.

M. W. Rudderow, American Pulley Company, vice-president.

F. D. Patterson, The J. G. Brill Company, chairman Publicity Committee.

J. P. Mudd, The Midvale Steel Company, P. O. Box 1322, secretary-treasurer.

Program Committee—J. F. Conner, The United States Gas Improvement Company, chairman; C. C. Black, Department of Labor and Industry, 904 Finance Building; L. J. Freund, Hoopes & Townsend.

Membership Committee—Coleman Sellers, Jr., William Sellers & Co., Inc., chairman; R. A. Medina, Independence Inspection Bureau; D. N. Frazier, American Mutual Liability Insurance Company.

The Committee on Publication regret the omission of the names of Messrs. George W. Baker and M. J. McCrudden as members of Company "E" of the Building and Equipment Fund Campaign, published on page 426 of the September PROCEEDINGS.

The official Club emblem, adopted December 12, 1916, is a clasp pin, solid gold, black enamel, with safety catch, and may be purchased at the Secretary's office for \$2.50. Cost with forwarding postage is \$2.62.

CALENDAR OF REGULAR MEETINGS

THE ENGINEERS' CLUB AND AFFILIATED SOCIETIES

1917-1918

DAY OF MONTH AND WEEK	NAME OF SOCIETY
First Monday	American Society of Civil Engineers October 1, January 7, April 1.
Second Monday	American Institute of Electrical Engineers October 8, November 12, December 10, January 14, February 11, March 11, April 8, May 13, June 10.
Second Tuesday	Engineers' Club (Junior Meeting) October 9, November 13, December 11, January 8, February 12, March 12, April 9.
Third Tuesday	Engineers' Club (except December, January and February) October 16, November 20, March 19, April 16, May 21, June 18.
Fourth Tuesday	American Society of Mechanical Engineers November 27, December 11, January 22, February 26, March 26, April 23, May 28, June 25.
First Wednesday	Technology Club October 3, November 7, December 5, January 2, February 4, March 6, April 3, May 1, June 5.
Third Wednesday	Engineers' Club (December and January) December 19, January 16.
First Thursday	Worcester Tech. Club October 4, November 1, December 6, January 3, February 7, March 7, April 4, May 2, June 6.
Second Thursday	American Society of Heating and Ventilating Engineers October 11, November 8, December 13, January 10, February 14, March 14, April 11, May 9, June 13.
Fourth Thursday	Society of Automotive Engineers October 25, November 22, December 27, January 24, February 28, March 28, April 25, May 23, June 27.
Second Friday	Engineers' Club (February) February 15.
Third Friday	Illuminating Engineering Society October 19, November 16, December 21, January 18, February 15, March 15, April 19, May 17, June 21.

Engineers' Club Meetings at Witherspoon Hall will be as follows:

Tuesday, October 16, Joint Meeting with **American Society of Mechanical Engineers.**
 Tuesday, November 20, Joint Meeting with **Worcester Tech. Club.**
 Wednesday, December 19, Joint Meeting with **American Institute of Electrical Engineers.**
 Wednesday, January 16, Joint Meeting with **American Society of Civil Engineers.**
 Friday, February 15, **Engineers' Club Meeting.**

Members of all Affiliated Societies are invited to these meetings.

COMMITTEE ON MEMBERSHIP

D. ROBERT YARNALL, CHAIRMAN

CANDIDATES FOR MEMBERSHIP

Members having knowledge of the candidates are invited to submit to the Committee on Membership before October 8 a confidential expression of opinion as to the eligibility of the candidates; all communications to be addressed, "Chairman of the Committee on Membership, Engineers' Club, Philadelphia," marked "Confidential."

All applications are on file at the Club and can be referred to by any member.

FOR ELECTION TO ACTIVE MEMBERSHIP

JOSEPH FRANCIS COONEY

Forty-fifth Street and Osage Avenue, Philadelphia, Pa.
District Sales Manager, Kaustine Company, Inc.

Proposed by J. R. Mertz and Arthur C. Emlen.

FRANK HUCKEL, JR.

663 East Penn Street, Germantown, Philadelphia, Pa.
Manager, Heating Department, Heating Engineer, Keystone
Supply and Manufacturing Company.

Proposed by William H. Walters and William A. Purks.

FRANK H. MCGRAW

Lester, Pa.

General Superintendent, Construction, Westinghouse, Church,
Kerr Company.

Proposed by Henry C. Smith and J. R. McGraw.

WILLIAM JOSEPH MURPHY

1217 South Broad Street, Philadelphia, Pa.
Heating Contractor, Secretary, Harry F. Murphy & Co.
Proposed by William H. Walters and H. P. Gant.

CHARLES E. O'HALLORAN

5839 Cedarhurst Street, Philadelphia, Pa.
Technical Stage Director and Superintendent, American Academy of Music.

Proposed by James F. McCrudden and Moriz Bernstein.

WALTER RANDALL RICHARDS

1809 North Broad Street, Philadelphia, Pa.
Assistant to Power Engineer, The Electric Storage Battery
Company.

Proposed by William H. Walters and William A. Purks.

LEWIS BEVERLEY VAN LEUREN

Delaware Street, Woodbury, N. J.
Superintendent, Vacuum Oil Company.
Proposed by A. H. Holcombe and James S. Merritt.



POSITIONS OPEN

The Duquesne Light Company of Pittsburgh, Pennsylvania, offers exceptional opportunities to Mechanical Engineers interested in modern power station work. The company is growing rapidly and has openings for trained and experienced technical men; also for younger men with technical training in mechanical engineering. Apply in person or by letter to Mr. J. M. Graves, Superintendent of Power Stations, Duquesne Light Company, Pittsburgh, Pa., giving your training, experience, and class of work desired, whether operating, efficiency work, or designing.

Young versatile engineer, electrical, with knowledge of mechanical drafting, for growing concern making electrical test apparatus, to assist Manager in all functions, and to take his place during absence. Excellent opportunity for a live versatile man who is ready to apply himself. Apply Engineers' Club No. 166-A.

Young man with manual training education. Position as assistant to draftsman, in the Construction Engineer's office. Apply Engineers' Club No. 167-A.

POSITIONS WANTED

Construction engineer, seven years' experience, four years' office practice, desires position. Specialized in reinforced concrete buildings, foundations, boiler and power plant erection and installation of power, light, high and low pressure piping and textile mechanical equipment. Apply Engineers' Club No. 162.

Construction engineer, wide experience, desires position. Apply Engineers' Club No. 163.

COMMITTEE ON COÖPERATION FOR NATIONAL DEFENSE

GEORGE R. HENDERSON, CHAIRMAN

MEMBERS OF ENGINEERS' CLUB WHO HAVE BEEN CALLED INTO SERVICE IN THE ARMY OR NAVY OF THE UNITED STATES AS OF SEPTEMBER 24, 1917

NAME	RANK	CORPS	LOCATION
ANDERS, D. W.	Captain	Engineer Officers' Reserve	
ANDREWS, J. H. M.	Major	1st Penna. Engineers	Camp Hancock, Augusta, Ga.
ASPLUNDTH, E. T.	Captain	1st Penna. Engineers	Belvoir, Va.
BELL, FRANK F.	1st Lieutenant	Signal Corps, Aviation Station	Essington, Pa.
BRADFORD, J. S.	Captain	1st Regt. Penna. Engineers	Camp Hancock, Augusta, Ga.
BREEN, J. W.	Captain	Engineer Officers' Reserve	
BROADHEAD, ALEX.		"B" Company, Engineer Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
BROWN, R. V.	Lieutenant	Q. M. C., 304 Divisional Trains	Camp Meade, Admrial, Md.
BRYANT, C. M.		Naval Coast Defense	Philadelphia Navy Yard
BUTLER, E. N.	2nd Lieutenant	1st Regt. Penna. Engineers	Camp Hancock, Augusta, Ga.
CACCAVAJO, Jos.	Captain	Engineers' Training Camp	Washington, D. C.
CARNEY, R. E.	{ Asst. Engr. U. S. N. (Retired) }	Pearl Harbor Naval Station	Hawaii
COLGAN, R. J.	Captain	American Expeditionary Forces	Care of Adjutant-Gen'l, Washington, D. C.
CRAMPTON, G. S.	Major	Medical Corps, National Guard	Camp Hancock, Augusta, Ga.
CUTLER, JAMES B.		Reserve Officers' Training Camp	Fort Oglethorpe, Chattanooga, Tenn.
DONNELLY, J. B.	1st Lieutenant	1st Regt. Penna. Engineers	Camp Hancock, Augusta, Ga.
ELCOCK, CHAS.	1st Lieutenant	1st Regt. Penna. Engineers	Camp Hancock, Augusta, Ga.
FULWEILER, J. E.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
GARFORTH, EZRA		Engineers' Training Camp	American University, Washington, D. C.
GAUM, CARL G.	1st Lieutenant	Engineers' Training Camp	Washington, D. C.
GAUTHIER, JORDAN	2nd Lieutenant	Engineers' Training Camp	American University, Washington, D. C.
GETZ, RALPH F.		Engineer Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
GRAVELL, W. H.		Engineers' Training Camp	American University, Washington, D. C.
GWILLIAM, MARK R. M.	2nd Lieutenant	21st U. S. Infantry	
HALL, W. A.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
HARDING, R. L.		Engineers' Training Camp	American University, Washington, D. C.
HATHAWAY, H. K.	Captain	Ordnance Officers' Reserve Corps	Washington, D. C.
HAYDOCK, ROGER		Engineers' Training Camp	American University, Washington, D. C.
HETHERINGTON, F. C.	Lieutenant	315th Infantry	Camp Meade, Admiral, Md.
HOLLENBACK, E. E.	Major	1st Pennsylvania Infantry	Camp Hancock, Augusta, Ga.
KERN, F. X.		Engineers' Training Camp	American University, Washington, D. C.
KNOWLES, MORRIS		4th National Army Division Cantonment	Admiral, Md.
LAWRENCE, G. E.	Lieutenant J.G.	Naval Coast Defense	Philadelphia Navy Yard
LAWSON, T. W.	Lieutenant	1st Penna. Infantry	Camp Hancock, Augusta, Ga.
MAGEE, J. W.	2nd Lieutenant	Engineers' Training Camp	American University, Washington, D. C.
MCCORD, J. B.	Captain	Ordnance Officers' Reserve	War Department, Washington, D. C.
McMILLAN, H. L.	Captain	Engineer Officers' Reserve Corps	American University, Washington, D. C.
MOODY, WM. M.		Reserve Officers' Training Camp	Fort Oglethorpe, Chattanooga, Tenn.
MYERS, W. T.	2nd Lieutenant	U. S. Cavalry	
NEWLIN, E. M.	Captain	312 Machine Gun Battalion	Camp Meade, Admiral, Md.
NIXON-MILLER, W.	Captain	Instructor, 20th Regiment Engineers	
O'CONNOR, C. P.	Captain	19th Regt. Reserve Engineers	American Expeditionary Forces, France
PERRY, EDWARD		Quartermaster's Officers' Reserve	Camp Lee, Petersburg, Va.
REED, R. W.	Private	"E" Company, Engineer Officers' Reserve	9th Engineers' Reserve Regiment, Philadelphia
RENINGER, H. A.	{ Major & Adju- tant, A. G. Dept. }	53rd Depot Brigade	Camp Hancock, Augusta, Ga.

COMMITTEE ON COÖPERATION FOR NATIONAL DEFENSE

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WILSON, L. B.	Private	Company I, 1st Pennsylvania Infantry Rockville, Pa.
WORTH, J. G.	Captain	Quartermaster Officers' Reserve Camp Wheeler, Macon, Ga.

ELECTRIC CODE—(Continued from Page 476)

Cords shall have an additional insulating tubing protection.

(2) All exposed noncurrent-carrying metal parts shall be permanently grounded and all current-carrying metal parts shall either be permanently grounded or adequately shielded. (See rule 391.)

(3) All equipment shall be so located that persons coming into contact with the equipment shall be obliged to stand either on an insulated platform or in a booth of suitable insulating material.

393. Grounding of Arresters for Signaling Systems

The ground connections for outside installations of cable protectors employed solely to prevent electrical injury to the cable need not conform with the requirements of this rule. For rules governing the grounding of the metal cases of outdoor apparatus as covered by this section, see section 9.

(a) Arresters shall be permanently and effectively grounded in the following manner:

(1) *Ground Conductor*.—The ground conductor shall preferably be of copper (or other material which will not corrode under the conditions of use) and shall be not less than No. 18 in size and in urban districts or where within buildings shall be covered with a suitable insulation.

If necessary to guard the ground conductor from mechanical injury (on poles or where a ground conductor on the outside of building walls is near a roadway, sidewalk, or pathway, thus necessarily exposing it to tampering by unauthorized persons), it shall be protected for a distance of 8 feet from the ground by a wooden molding or by conduit of non-magnetic material.

(2) *Ground Connection*.—The ground connection shall be made to a cold-water pipe, where available, con-

nected to the street mains and in service. An outlet pipe from a water tank fed by a street main may be used provided such outlet pipe is adequately bonded around the tank to the inlet pipe connected to the street main.

If a cold-water pipe is not available, the ground connection may be made to a gas pipe, provided the ground conductor is attached to the pipe between the meter and the street mains.

If cold-water or gas pipes are not available, the ground connection may be made to an iron rod or pipe driven into permanently damp earth, or to a plate or other body of metal buried in permanently damp earth. (Compare rule 93.)

Steam or hot-water pipes should not be used for ground connections.

Driven rods or pipes, used as ground connections for protectors, shall not be also used as ground connections for electrical supply circuits or electrical apparatus, and where water or gas pipes are used for a ground connection, attachment to such pipes shall be made at a different point than for attachments to electrical supply circuits or equipment.

(b) *Connecting Ground Conductor to Pipes*.—Ground conductors shall be attached to pipes by means of suitable ground clamps; the entire surface of the pipe to be covered by the clamp shall be thoroly cleaned.

(c) *Connecting Ground Conductor to Driven Rod or Pipe*.—The ground conductor shall be so attached to the rod or pipe as to give reliable connection both mechanically and electrically and in such a manner as to prevent corrosion when the joint is buried in the earth.

(d) *Connecting Ground Conductor to Buried Electrode*.—Where buried plate or other metal electrode is employed the ground conductor shall be securely fastened to it in such manner as to make a reliable electrical and mechanical contact.

(To be concluded in November Journal)

A DISCUSSION OF THE FUNDAMENTAL PRINCIPLES OF WATER-WORKS VALUATION.

(Continued from Page 448)

real estate, the value of the water supply would immediately drop in proportion to the cost of obtaining equivalent water at the next cheapest site. So these are the principles that must be kept in mind when appraising the market value of the water supply: It can never be greater than the actual cost to obtain a supply just as good in every respect. It can never be worth more than the water company can afford to pay for it, based on the net revenue obtainable from the water company's patrons. Therefore the appraiser is justified in taking the lower of these two figures as the market value of the water supply, and no one can fairly deny the water company's claims, so long as the laws of private ownership of natural resources are as at present.

SEVERANCE VALUE

Either when a city desires to negotiate for purchase or to condemn a portion of a water-works system owned by a water company, the appraiser is confronted with the question of what is the value as a whole and what is the value of the portion left to the water company. The difference is the "severance damage."

If only the water supply is taken, obviously the damage is measured by what will be the cost incident to the introduction of an equivalent water supply, and if none other is obtainable, the damage may be the value of the entire works less its scrap value.

The most frequent case, however, is where the city takes the piping system within the city limits and leaves to the water company its water supply and the territory which it supplies outside of the city. In that case the appraiser will be obliged to determine the market value of the plant as a whole and of the portion remaining. The difference will be the "severance value," or the value of the portion taken by the city.

To determine the amount, it is necessary to make a forecast for a long term of years of the net revenues in each case, giving due consideration to any salvage items that would certainly accrue to the water company and be of no service to the remaining plant.

Evidently the "historical cost" or the "estimated cost of reproduction" should have little if any weight when appraising "severance value."

In forecasting the net revenues, however, full consideration must be given to the required improvements to keep abreast of the growing demand in each case.

The Committee on Publication desires to express appreciation to Mr. John W. Ledoux for his paper on "Engineering Reports," which appears editorially in this number.

GEORGE S. CHEYNEY.*(Continued from Page 486)*

arduous the task. He was resourceful, original, and a good judge of human nature.

Altho he was unassuming, modest, and somewhat diffident, he had some very original notions about politics, public morals, the proper relations of the State to Business, etc., in all of which he was greatly interested. He

had a very highly cultivated sense of humor, and always had at his command an appropriate story or anecdote to impress upon the memory some important truth.

To those of us who knew him well he was interesting, kind, sympathetic, and a mighty good fellow.

JOHN W. LEDOUX.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS .: PHILADELPHIA SECTION

NATHAN HAYWARD, Chairman

H. MOURADIAN, Secretary, 1631 Arch Street

OCTOBER 8TH MEETING

THE October 8th meeting, as announced in the September PROCEEDINGS, will be a national meeting of the American Institute of Electrical Engineers.

The general subject of the meeting will be "Industrial Research," and the speakers will be:

DR. A. E. KENNELLY, Director of the Research Division of the Electrical Engineering Department of the Massachusetts Institute of Technology.

MR. CHARLES E. SKINNER, Engineer of the Research Division of the Westinghouse Electric and Manufacturing Company.

DR. FRANK B. JEWETT, Chief Engineer of the West-ern Electric Company.

These men are all experts on research organization and procedure and, while all are actively engaged in work for the national defense, they have taken time to prepare papers on this subject, which is one of world-wide importance, particularly in this period of technical development.

The meetings will be held in the Bellevue-Stratford Hotel both afternoon, at 2:30, and evening, at 8.

The committee in charge of the arrangements for the meeting consists of:

J. L. Beaver	W. F. James
C. E. Clewell	E. B. Tuttle
H. Goodwin, Jr.	S. B. Williams
J. L. Kilpatrick, Chairman	

The dinner committee consists of:

J. D. Israel	J. S. Francis
M. G. Kennedy	H. F. Sanville
W. O. Kurtz	Thos. Sproule
J. H. Beaver, Chairman	

The subject of the meeting will be treated in a very broad way and should prove of interest to other than electrical engineers, and we desire to extend a cordial invitation to all members of The Engineers' Club and Affiliated Societies to attend the meeting and take part in the informal dinner, which will be held between the afternoon and evening sessions. Those desiring to attend the dinner should notify some member of the dinner committee a few days in advance, if convenient.

TECHNOLOGY CLUB OF PHILADELPHIA

H. A. TERRELL, President.

N. A. WHITE, Secretary, Wenonah, N. J.

THE first meeting of the season will be held on Wednesday evening, October 3. There will be the usual informal dinner at 6.30 P.M., and meeting at 8.15 P.M. Prof. H. G. Pearson, of the English Department of the Institute, will address the Club on "Technology's War Activities." It is expected that Mr. James P. Monroe, '82, Chairman of the M. I. T. Committee for National Service, and Mr. John M. De Bell, '17, in charge of the Washington Bureau, will be present. Professor Pearson has recently completed a country-wide tour of the various Technology Clubs to awaken interest in the Institute's activities in support of the Government. With a Navy aviation school, a school for Naval Reserve cadets, and an Army aviation school located at Technology, and with the new Walker Memorial Building in use as barracks, Professor Pearson's talk will be most interesting.

The fifth reunion of the Technology Clubs, Associated, will be held in Philadelphia next spring, and delegates from a large proportion of the various clubs

thruout the country will attend as guests of the Philadelphia Club. The active participation of each member in our local club affairs during the coming season is necessary in order that we may make the reunion a success and an occasion worthy of Philadelphia.

Mr. G. W. Barnwell is at the Officers' Training Camp at Fort Myer, Va., and has therefore resigned as secretary. N. A. White was elected secretary by the Executive Committee. Barnwell is in the Coast Artillery Corps and will go to Fortress Monroe for two months' training after a month at Fort Myer. He writes that "it is likely that we will see foreign service much sooner than the infantry or Dough Boys." Other members of the club in Uncle Sam's service, in addition to those previously mentioned, are Parry Keller, '15, First Lieutenant, Ordnance Department, U. S. A., stationed at Frankford Arsenal, and Charles Gaskill, '99, in France with the Nineteenth Regiment Railroad Engineers.

EDITORIAL

(Continued from Page 481)

laboriously to collate a mass of obvious data for the sake of making his report look valuable to those who may not recognize the few words of intrinsic worth that represent the gist of the report. He, therefore, either must

entrust the padding to others, omit it altogether, or apply himself to a labored and distasteful task.

From a commercial standpoint, however, the young engineer cannot afford to be too brief or commonplace—his reliability and reputation must first have been thoroughly established before he dare write his report, as it were, on the back of an envelope.



AMERICAN SOCIETY OF MECHANICAL ENGINEERS .: PHILADELPHIA SECTION

LEWIS F. MOODY, Chairman. JOHN P. MUDD, Secretary, Midvale Steel Company, Nicetown, Pa.



MEETING NOTES

THERE will be a joint meeting with The Engineers' Club in Witherspoon Hall at 8 p.m. October 16.

Mr. Homer L. Ferguson, president and general manager of The Newport News Shipbuilding and Dry Docks Company, will speak on the subject of "Problems of Shipbuilding." The meeting has been arranged thru the kindness of Mr. H. Birchard Taylor, of The William Cramp & Sons Ship and Engine Building Company.

On November 27 a meeting will be held at The Engineers' Club, the evening to be given over to a general discussion. The program is being arranged by the New

York Committee on Sections, of which Mr. D. Robert Yarnall, of Philadelphia, is chairman. The other members of the committee are:

L. C. Marburg

C. R. Richards

Walter Rautenstrauch

E. H. Whitlock

The December meeting will probably be upon "Offensive Against the Submarine," by Joseph A. Steinmetz.

Other matters scheduled for the year are "Navy and the War," by Prof. William L. Cathcart; supplement to Taylor's "Art of Cutting Metals," by Carl Barth; "Recent Developments in Material Specifications," by Dr. S. W. Stratton, director of U. S. Bureau of Standards.



AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS EASTERN PENNSYLVANIA CHAPTER

GEORGE W. BARR, President

GEORGE BOON, Secretary



THE Board of Governors has announced a "Smoker and Light Lunch" in conjunction with the regular meeting, October 11. A cordial invitation is extended to those interested in heating and ventilation to attend and participate in the discussions.

The principal topic for discussion at this meeting will be fuel conservation. A representative of the coal merchants of Philadelphia will attend and present their views.

On account of the recent criticisms of the National and Local Medical Boards, regarding the heating, without ventilation, of the barracks at the several cantonments now under construction, this subject is of special

interest, as recommendations have been made by the American Society of Heating and Ventilating Engineers and in some States have been adopted.

Members are unanimous in their approval of the Chapter's Year Book as tangible evidence of the labors of the committee in charge of the printing. Additional copies can be secured on application to the Secretary.

President Barr advises that members can best show their interest in the Chapter's welfare by not only being present at the meetings, but by taking active part in the proceedings.

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AND AFFILIATED SOCIETIES

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XXXIV-11

NOVEMBER, 1917

No. 156

CONTENTS OF THIS ISSUE

	PAGE		PAGE
The War's Effect on Merchant Shipbuilding.	499	Experienced Highway Construction Men for Service in France.	526
By HOMER L. FERGUSON		(Authorized by COLONEL JOHNSTON, Commanding the 23d Engineers)	
Electric Code—Adopted by the Industrial Board, Pennsylvania Department of Labor and Industry, Operative on and after July 1, 1917.	506	Illuminating Engineering Society.	527
Officers, Directors, Standing and Special Committees of Engineers' Club.	515	Address by WILLIAM J. SERRILL, Retiring President	
Committee on Papers.	516	American Institute of Electrical Engineers.	533
LEWIS H. KENNEY, Chairman		American Society of Mechanical Engineers.	534
Synopsis of Paper "Engineering and Construction Features of Cantonments"	517	Technology Club of Philadelphia.	535
By MAJOR RICHARD C. MARSHALL, JR., U. S. A.		Philadelphia Association of Members of American Society of Civil Engineers.	535
Calendar of Regular Meetings of The Engineers' Club and Affiliated Societies—1917-1918.	518	Society of Automotive Engineers.	536
Secretary's Notices.	519	American Society of Heating and Ventilating Engineers.	537
Committee on Membership.	522	The War Committee of Technical Societies.	537
D. ROBERT YARNALL, Chairman		The New War Truck Design.	545
Positions Open.	523	Industrial Research and Its Relation to University and Governmental Research.	546
Committee on National Service.	524	By C. E. SKINNER	
GUILLIAEM AERTSEN, Chairman		Industrial Research and the Colleges.	549
		By A. E. KENNELLY	
		Index to Advertisers.	ix

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Contributions on topics of interest to the members of the Club and Affiliated Societies are cordially invited. All matter for publication, including advertising copy, must be in the hands of the Editor by the 15th of the month for the issue of the following month.

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SPANISH AT YOUR FINGERS' ENDS

The translation of the Spanish to the English or the English to the Spanish requires less than five seconds for any word by the use of our new SPANISH-ENGLISH and ENGLISH-SPANISH DICTIONARY—just from press. A complete key to the pronunciations and—for those who want to delve more deeply—the parts of speech, nouns, lists of adjectives, pronouns, adverbs, prepositions and conjunctions will be found in the opening pages.

Of all the languages the Spanish is regarded by many as the easiest to learn. The beginner is at once impressed with the striking similarity to our own. Even in the business world many little adaptations have been made from the Spanish to the English. The manufacturer of one of the most popular five cent cigars has drawn on the Spanish for his trade-mark as you will note from the sample opposite.

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J. B. LIPPINCOTT COMPANY
PHILADELPHIA, PA.

C NEW SPANISH-ENGLISH DICTIONARY

cieno, <i>sm.</i> mud.	cierno, <i>sm.</i> mate, assist-
ciento, <i>a.</i> one hundred;	ant.
—, <i>sm.</i> a hundred.	ciervela, <i>sf.</i> plum, prune.
cierte, <i>en</i> —, to be in (its)	ciervano, <i>sm.</i> surgeon.
estar en —, to be in (its)	cisterna, <i>sf.</i> cistern.
infancy.	cita, <i>sf.</i> appointment, as-
cierro, <i>sm.</i> enclosure.	signation, rendezvous;
cierto, <i>a.</i> certain, evident.	citation, quotation.
cifra, <i>sf.</i> cipher; abbrev-	citación, <i>sf.</i> quotation;
viation.	summons.
cigarro, <i>sm.</i> cigar.	citano, <i>sm.</i> such a one.
cigarrillo, <i>cigarrito</i> , <i>sm.</i>	citerior, <i>ad.</i> hither, nearer.
cigarette.	ciudad, <i>sf.</i> city; civic
cilla, <i>sf.</i> granary.	body.
cima, <i>sf.</i> summit; nap:	cívico, <i>ca.</i> a. civic.
top of trees.	civil, <i>a.</i> civil; polite, cour-
cimentar, <i>v.a.</i> to lay the	teous; (law) not crim-
cimentar, <i>v.a.</i> to lay the	inal.
foundation of a build-	civilizar, <i>v.a.</i> to civilise.
ing; to ground; to re-	civismo, <i>sm.</i> patriotism.
fine metals.	clamor, <i>v.a.</i> to clamor.
cimenterio, <i>sm.</i> cemetery.	clara, <i>sf.</i> short interval of
cimento, <i>sm.</i> cement.	fair weather on a rainy
cincel, <i>sm.</i> chisel.	day; white of an egg.
cincos, <i>a.</i> & <i>sm.</i> five.	clarear, <i>v.n.</i> to dawn; —, <i>ss.</i>
cincuenta, <i>sm.</i> fifty.	to be transparent; to
cincuenteno, <i>na.</i> a fiftieth.	clear up.
cincinar, <i>v.a.</i> to girth.	clarete, <i>a.</i> vino —, <i>sm.</i>
cinematógrafo, <i>sm.</i> cine-	clarete.
matograph (moving	clarín, <i>sm.</i> trumpet; trum-
pictures).	peter.
cigaro, <i>ra.</i> a. gipsy.	claro, <i>ra.</i> a. clear, bright;
cinta, <i>sf.</i> ribbon, tape.	intelligible.
cintura, <i>sf.</i> girdle; waist.	class, <i>sf.</i> class, rank; or-
circo, <i>sm.</i> circus.	der.
circular, <i>v.a.</i> to surround.	clasificar, <i>v.a.</i> to classify.
circulación, <i>sf.</i> circula-	claudicar, <i>v.n.</i> to halt, to
tion; currency.	limp.
circular, <i>a.</i> circular, circu-	cláusula, <i>sf.</i> period; clause.
latory; —, <i>v.n.</i> to cir-	clavar, <i>v.a.</i> to nail; to
culate.	fasten in; to force in; to
circulo, <i>sm.</i> circle; circum-	drive into; to drive a
ference; district; orb;	wedge; (fig.) to cheat, to
compass.	deceive.
circunstancia, <i>sf.</i> circum-	clavícula, <i>sf.</i> clavicle.
stance.	clavija, <i>sf.</i> pin, peg.
circunvecino, <i>na.</i> a. neigh-	clemencia, <i>sf.</i> clemency.
boring, adjacent.	

Pron. a, ah; e, ay; i, ee; o, oh; u, u (in full); y, es.

INDORSED BY SPANISH CONSULS

José T. Henao, Consul for Colombia, writes:

"I have found your Dictionary a most useful little book, containing the exact meaning of the words, without long and tiresome explanations, which in my opinion give the beginner more trouble than they are useful to him. I will be very glad to recommend this work to all my friends whom I am sure will appreciate its value."

Dr. Luis, Consul for Republic of Cuba, says:

"Have found the book especially interesting and valuable for the Spanish-English speaking population. Your book will render a very good service to students and business people," etc.

J. R. Lopez, Consul for Mexico, says:

"Its key to pronunciation at the foot of every page; its alphabetical list of abbreviations; its plain and clear type so adequate to the reader's eye; and its general constructive wording of grammatical meaning, are such wonderful assets to the volume, that I do not hesitate in strongly recommending it to the Spanish-English speaking population."

THE
JOURNAL
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VOL. XXXIV-11

NOVEMBER, 1917

No. 156

THE WAR'S EFFECT ON MERCHANT SHIPBUILDING*

By **HOMER L. FERGUSON,**

PRESIDENT OF THE NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY

MR. CHAIRMAN, LADIES AND GENTLEMEN: My only excuse for being here is that I feel it is just as well that the people in our business and interested in it and living in the great center of shipbuilding in this country should know at this time that we who live in the outlying districts, as it were, are as vitally interested as you yourselves in doing our bit and seeing that the war is prosecuted to a successful finish, and that we, with you, shall not be satisfied with any peace except the peace that goes with victory.

It seems superfluous for anyone to come to Philadelphia to talk about shipbuilding or the war's effect on shipbuilding, because on the Delaware River there are a number of magnificent new shipyards, and all the old ones are being improved and are running up to and over capacity. Improvements have been made in some of them to such an extent they would hardly be recognized by one who has not been here for the past four or five years.

In speaking of what we shipbuilders are doing and contemplate doing, I feel somewhat like a friend of mine on the general staff of the Army. He said he had so many secrets he was almost afraid to go to sleep at night for fear he would talk in his sleep and give some of them away. My principal criticism, as a civilian, of the war, is that in some aspects it is like looking at a baseball game without knowing what the score is or who is at the bat. The news that an unknown ship on an unknown sea encountered an unknown submarine, and that an unknown person had lost his life, may be interesting to a great many people, but it is very dull reading. It is hoped that before we get thru some ginger will be put into the situation, so that we will feel as if we are in a fight; and personally I feel that publicity in the United States is the only way in which the people can be aroused. Publicity will come sooner or later in the casualty list, if not in some other way, and then we will know as a people that we are at war. Censorship is very well in so far as it maintains necessary secrecy, but my own judgment is that it is very much overdone. It is

of course necessary to watch the cables and the wireless to see that no improper information is carried abroad.

In a military sense, this war is narrowed down to the question as to whether the German submarines can sink the English ships and those of the Allies at such a rate as to force peace upon Great Britain, ourselves and the other Allies before the Germans are sufficiently thrashed on land to recognize that fact. When the submarine campaign was started in February, the German Minister of the Navy promised his people that in August of this year England would be brought to her knees. The rate of sinking for a time increased until it became probably three or four times the rate of building.

There have been two schools of thought regarding the proper method of meeting the German submarine campaign. One school has held that only by the production of the maximum number of ships in the shortest space of time until the production of new vessels should more than equal the destruction of vessels in being, would the question be answered. The other school has held that there were vessels in plenty to feed England and to carry our troops to France and to feed them, and that the proper method to meet this menace was to build a large number of submarine chasers, destroyers and other vessels of war to go after the submarine itself. There is a very strong feeling that catching the submarine away from its base is something like catching bees out among the flowers instead of in the hive.

We are told now—at least it is hinted at in the newspapers—that Admiral Mayo and his staff back from Europe contemplate sending our fleet into a close blockade of the German U-boat. That could be probably done.

The exponent in an official way of the theory of building the maximum number of ships is, of course, the United States Shipping Board, with the Emergency Fleet Corporation as the largest individual owner and builder of merchant ships anywhere, either at this time or at any other time in the history of the world. All of the shipbuilders have had their new ships commandeered by the Shipping Board, and these ships are now being pushed to completion under the direction of the Shipping Board. In addition to the ships under construction at the time the Shipping Board took over all these

* Address delivered at a Joint Meeting of the Engineers' Club of Philadelphia and the Philadelphia Section, American Society of Mechanical Engineers, at Witherspoon Hall, Tuesday evening, October 16, 1917.

vessels on August 3d last, the Shipping Board has placed contracts for 200 to 300 additional steel ships and for about 200 wooden and composite ships. The English have built ships at a very rapid rate during the past six months, but prior to that time their capacity had fallen off woefully. The figures of British shipbuilders are that in normal years their capacity in tons was about two million. In 1915 they built only 700,000 tons. In 1916 only 550,000 tons. In the first six months of 1917 they built 500,000 and by the end of 1917 they will have built during this year almost two million tons, or practically their normal tonnage.

In comparison, it is interesting to look at our record, which is mostly in the future. The largest tonnage ever built by us in any year prior to the present year was in 1908, when we built 615,000 tons. In 1917, or at the end of the fiscal year of 1916-17, on July 1st, the total tonnage turned out in merchant ships in this country was close to 800,000 tons. Of course we expect that that will be bettered very much, and the production, except for labor difficulties, would have been very much greater than that; but it is a far cry from 800,000 or 1,000,000 tons of ships a year to a prospective 2,500,000 to 5,000,000 tons of ships a year, and especially when we consider that the best the first shipbuilding country of the world ever did in any one year was only 3,000,000 tons.

Now as to the methods of turning out such an enormous tonnage in a short time. The standardized ship was first thought of by Noah. It certainly would have been had he built a second ark. Every other ship builder has thought what a joyful thing it would be if he could only build two or three or four ships just alike. If the war does nothing else for shipbuilding, it will at least demonstrate that the individual tastes of individual owners need not be met in every instance. Building a ship is somewhat like building a house, and I dare say even the ladies present will agree with me that none of them has ever seen a house built which they would not change here and there—certainly in closet space if nothing else; and it is very much so with ships. Ships are not built alike for the reason that ships are built by units and tens instead of by thousands. And what applies to the automobile industry or hat industry or any other industry where the units are small and the aggregate number is very large is not possible where you are building a thing that is worth half a million or a million or more. It is certainly not possible under ordinary circumstances with a very scattered ownership. But with a single ownership, like the Emergency Fleet Corporation, it becomes possible for the owner to specify that all ships shall be alike, and thus we have standard ships!

There is an idea extant that if a ship is called "fabricated" or "standardized" it becomes rather easy to build. It does become easier to build, but it is not any easier to drive a rivet in a fabricated ship than in a common ship, and the 7500-ton fabricated ship will have about 650,000 rivets and some riveters must do a considerable amount of work to drive those rivets in that ship the same as

in any other ship. The most onerous work in building a ship is in the driving of the rivets; and, if any concern is going to build one ship a week, it must drive 650,000 rivets a week. When we consider that the best rivet drive is by the Union Iron Works, where they drive 250,000 rivets a week, and the next best by the three largest shipyards on this coast is about 200,000 rivets each per week, the problem of driving 650,000 rivets a week assumes a rather difficult aspect to the casual observer. Still, we all hope it will be done, but if it is done it means the importation of an enormous number of new workers into the industry.

The fabricated ship has the center of the stage at the present time. In England a standardized ship was adopted which is very much like a fabricated ship, and they are being turned out at a rapid rate. The first ships have already been completed and are on the sea now, if indeed they have not already arrived in this country. The fabricated ship, like the English standard ship, has the disadvantage of low speed, and at the same time it has the advantage of a large carrying capacity. The records of submarine sinkings, such as have been gathered, indicate that speed is probably the safest defense against the submarine. The number of very slow ships sunk is very great in proportion to the number attacked. Probably 90 per cent. of the slow ships are sunk when attacked by a submarine. As the speed becomes greater the immunity of the ship from torpedo attack becomes greater—not only because she presents a more difficult target but also because the vessel may run away from the submarine in darkness or in daylight if she has a greater speed than the submarine has on the surface, and also because the vessel may be maneuvered much more quickly. One of the most gratifying things about submarine warfare is that the torpedoes are not making the speed as in the early days of the war. The speed of the torpedo has undoubtedly become much decreased. Just why we do not know, altho it is probably due to the absence of tungsten and manganese and some other ingredients now so difficult to obtain in Germany. Vessels of sixteen or seventeen knots have actually dodged the torpedoes.

The vessel of 16 or 17 knots is also needed to carry soldiers. We are shipping all our soldiers to Europe in vessels of 14 knots or over because it is thought to be too hazardous to ship them in the slower vessels. We have at the present time in this country enough vessels in commission to ship soldiers to Europe at the rate of not more than one million a year. That includes all vessels of 14 knots or over. But by building a large ship as well as a speedy ship an additional factor of safety is obtained, which may be illustrated by stating that a torpedo will blow just as big a hole in a little ship as a big ship. When a small, short ship has a large hole in it a relatively larger proportion of its length is open to the sea. When a similar hole is blown into a long ship a very much smaller proportion of that vessel is open to the sea. So that it is perfectly possible to design, and practical, indeed, to design, a ship of 500 or 600 feet long, so subdivided

that it will take two and probably three torpedoes of the German variety and still stay afloat. The design, however, must be of such character that when the compartments are flooded the ship will still remain upright. The requirements of passengers who go to sea are such that the ordinary passenger ship shall have a very small metacentric height. But with a small metacentric height the rolling of the vessel is very easy, so that the passengers are not made ill with the motion of the ship as easily as they would be if there were a large metacentric height and the ship rolled quickly and with a jerk. The ordinary passenger ship is modeled with a small metacentric height, and three-fourths of them, when bilged or torpedoed, will probably turn over before sinking.

A great deal of talk was heard years ago, when the *Titanic* went down, about making ships safe. The *Titanic* was probably the safest ship that ever crossed the ocean, with the exception of the *Olympic*. The *Empress of Ireland*, the *Lusitania* and the whole host of passenger ships of which we have any record have turned over as they went down, and they probably righted after they went down. So that in designing a ship that will be safe against submarine attack not only must the question of subdivision be taken care of so as to limit the length of the vessel that may be damaged by a torpedo, but also that the vessel when torpedoed will remain upright and be able to get into port. A number of vessels have been torpedoed and have been towed into port and repaired on the other side, even after the crews had deserted them. In fact there is a strong notion that the crews have been over-ready to desert the ships and have left when the ships were still afloat, which is proven by the fact that these ships have been towed in.

The larger type of ship which will probably be built before the war is over by a number of concerns in a position to undertake this work will be designed with a high speed for troop transport, with a close subdivision to make the ship safe, and with a large amount of stability so that the vessel will also be safe against turning over.

The war so far has developed, or called attention to, three distinct types of vessels: The standardized or fabricated ship like both the English and the United States have adopted, the large troop transport which has been described, and, in addition, the submarine chaser.

In addition to these three types of ships brought out by the war, there has been a very definite attempt to rejuvenate what some of us have considered a dead industry. I do not know whether there are many wooden ships building around Philadelphia or not, and I would not like to criticise the wooden ship builders; but I should like to see a few. We have a few of the older wooden ship builders left, but the building of a wooden vessel to my mind is so much more difficult than the building of a steel vessel and requires so much higher skill than does the building of a steel vessel that I wonder how they can ever expect to build them.

I do not believe that a 288-foot wooden ship built in

a lumber yard, either south, west or north, and necessarily by men who are not expert ship carpenters, will ever relieve any great distress on the other side of the water, caused by lack of fuel or food. On the other hand, these vessels may be used in our own trade at home. My chief regret is that they are not made shorter, because when such ships are over 200 feet long it is rather difficult to hold the ends up. If we get more vessels thru building wooden ships, let us build them, but it is unfortunate that the type was settled before many professional wooden ship builders were on the job. The wooden ship builders of course have taken a good many men from the steel shipyards and have lessened production to just that extent; but, on the other hand, they will add a very considerable tonnage, now that practically all our large coastwise ships are either going abroad or are in the way of being commandeered for foreign service, so that the wooden ship will serve a useful purpose.

The standard ship probably offers the best opportunity for a large increase in our tonnage. The standard ship has been built on the Great Lakes for years. Shipbuilding there has become largely a manufacturing operation for the reason that the ships themselves simply form a part of the manufacturer's business of carrying iron ore from Lake Superior down through the Canal to the eastern points where it is shipped to the steel furnaces. The loading and unloading of the ore permitted the standardization of docks, hatches and so on, and the method of construction became standardized because the work which the ship did was standardized. Many ask why we do not build ships just like they do on the Lakes, and the answer is that we do not do the same work that they do. On the coast, with the coal trade, there has been some effort toward standardization. With the standardized ship the main benefit is not in the hull of the vessel, or in the fabrication of the vessel in the steel mill. The main benefit is that the machinery and the outfit, the winches, the pumps, the steering gear, the engines and boilers and all the thousand and one things that go into the ship are standardized and may be produced in large quantities at some point other than the yard of the builder. The standardization of the fittings of a vessel are more important to my mind than the standardization of the hull. The amount of money saved in the latter will be the money to build the templates, patterns, etc., amounting to not more than 12½ to 15 per cent. of the labor cost of the hull. We are told, too, that all the riveting will be done at the steel mills. It probably will not and if 20 per cent. is done it will be more than I think will be done unless the railroads will carry pieces of steel as large as this auditorium.

Shipyards have naturally tried to standardize within their own practice the fittings that go on the various ships they build, and a great step is being made in that direction by one of the largest corporations in the country. The Bethlehem Company own so many shipyards that they are in a position to standardize as between their various yards, with the result that there will be considerable saving

in cost and in time in the production of all the things that go into a ship. But in building the standardized ship, or in building any other ship, the real problem is not the problem of equipment; it is not the problem of money even; it is not, except in part, the problem of location, but it is the problem of men. A very simple lesson in arithmetic will indicate that if 100,000 rivets are to be driven in one day and any one gang of riveters will drive 300, then it will take so many men and boys and helpers to get that drive. It is quite desirable to get back to our arithmetic again when we have built so many ambitious high hopes of what we expect to do. I can state for our Company, the most fortunate thing we did when this war started was that we only promised to deliver ships of the quantity that we had been delivering before. In other words, we did not capitalize our noble purposes and high ambitions, and I am very happy to say that we therefore have only about four more vessels on our hands for which we received a fixed price.

Saying that we are going to do a thing does not do it, and *hoping* that we are does not do it, and promising to the newspapers that we are going to build all these ships does not do it. As a matter of fact, enthusiasm and high hopes, unless counterbalanced by good judgment and experience, do more harm than good, because a good many people are lured into a sense of security that we are going to win against this submarine menace, when, as a matter of fact, there is nothing to justify any such conclusion. For instance, on the Delaware and on the Chesapeake, which we, on the Chesapeake, are pleased to consider the two largest shipbuilding communities in the United States, there are at present about 33,000 men employed in the shipyards. There could be employed to advantage in these same yards at this time a total of 48,000 men, and within the next six months, or the next nine months at the latest, these same yards, barring the fabricated shipyards, could employ to advantage a total of 60,000 men. So the problem becomes arithmetical again. You have 32,000 men working. To get the maximum production out of the shipyards already in existence you will need to use 60,000 men. Where are the 28,000 extra trained shipbuilders to come from? Add to that the fabricated shipyards, which on the Delaware will probably require 20,000 men, and in the vicinity of New York an extra 10,000, and we have in this immediate district need for approximately 60,000 new mechanics in the shipbuilding business.

According to Admiral Capps, there will be needed in the whole United States in shipbuilding within the next six months an additional 150,000 men. Now, consider for a minute where these men must come from or how we are to get them. In the first place, most shipbuilding men or mechanics require both skill and experience. We can give them the experience fairly quickly, but we have not time to give them the skill. In other words, it is necessary that men be recruited from industries where they do work similar to the work of shipbuilding in order that they may become quickly adapted to the work of ship-

building. I say other industries without specifying what particular industry. Of course, it would be natural to pick the non-essential industries if there are any such. But I would say that they should be taken from *any* other industry if necessary, because our problem in the war becomes the most difficult when the question of transportation is considered.

We are operating or preparing to operate 3000 miles from our base and that is the crux of the whole question. A reasonable solution has been proposed for every physical problem presented by this great war except the problem of over-sea transportation. I do not know whether it is giving away information that would be of benefit to the enemy to say that that transportation is entirely inadequate, but if anyone does not think so all he has to do is to look at the congestion in our various ports. The problem of over-sea transportation absolutely has to be met before we can get into the war effectively, and the problem of sea transportation is probably the most difficult of all problems we have to face. Therefore, the men should be furnished for the solution of this problem, no matter what industry they are taken out of. We are making a fine, large army; we are making all kinds of quartermaster supplies and guns and other things, but none of them are of any use whatever unless carried to Europe. Our soldiers must be carried to Europe, and not only that, but the soldiers that are carried to Europe must be fed and must have ammunition. The excitement created by the war so far will be but a gentle zephyr compared to the excitement that would permeate the United States if, perchance, we get a million men in France from the United States and they go hungry. My own opinion as a plain American is that that is the largest problem that looms up in the future. The distress that has been occasioned here by the sufferings of Frenchmen, Englishmen and Belgians and the different peoples of Europe will be very slight compared with what will be occasioned by some of our boys not having the proper blankets or foods or something else, all of which must be carried to them in ships. So that the problem of building these ships becomes a military problem of prime importance—the most important single problem that confronts us at the present time.

I have been quoted recently in an extract that I gave of this talk to the newspapers as favoring the conscription of laboring men. I do not say that I favor the conscription of laboring men, but I do say this—that sooner or later the United States will tell all men who are essential in any industry or any occupation in the prosecution of the war that *this* is their job and they are to stay by it until the war is over. It is perfectly ridiculous that our men who are already in Europe and those who are going there now should for a minute suffer on account of some difficulties that arise between employers and employees in the great shipyards of this country. Not only should the man who pounds iron and drives rivets be told that he shall be kept on his job, but also every employee in the company, from the president down to the office boy,

is to do the same thing, and he is not to seek or obtain other employment, except for good reason given the Government authorities. It simply comes down to this: Whether we are playing a game of amusing ourselves, or whether we are in to win. If we are in the war to win, no one should be timid about telling the laboring man or the unions or anybody representing them just what part they have got to play along with the part that other people should also play. In fact, when the war started a few of us in conversation with the Secretary of the Navy told him that we thought the thing for him to do was to commandeer the shipyards together with all their employees; to put us all on the Government pay-roll if he wanted to do so, and give us as many stripes on our uniform as he thought proper, and if we did not do as he thought the United States wanted us to do to court-martial us and send us down to Atlanta or some other convenient penitentiary. And I think something of that sort should be done. Any man who has charge of shipbuilding or engineering in any capacity who is not perfectly willing that that should be done both to himself personally as well as to his men has a very one-sided view of this war which needs to be corrected. Of course, it is held by the National Council of Defense, and by a number of exalted bodies that the *status quo* as between employer and employee should remain the same during this war. Of course, it should remain the same, and we all know that it is not remaining the same, and we all know that the labor leaders as a rule are unable to control the men.

There is a solution of this labor problem effected with the transport workers on the other side; Liverpool, for instance. A number of the soldiers were sent back to Liverpool and went to work. You will remember a few years ago in France a great threatened strike on the railroads was settled by making soldiers out of all the railroad employees. Our present stevedore troubles are in a fair way of being settled by giving the colored man a chance to be a stevedore instead of being a soldier in the trenches and so far as I have been able to observe in our neighborhood, several thousand of them are glad to take advantage of this glorious opportunity and are stevedoring for their country very quietly and very effectively, and I do not see why of all the men who have been passed into the National Army that we should not have in so essential an industry as shipbuilding those of them who are mechanics on conditions set by the Government and on pay to be approved by the Government, to work in these shipyards until the war is over, or until they should perchance prefer to go to the front instead of staying in the shipyards.

I understand that in Philadelphia it is very difficult to have any of the shipyard employees excused from military service. Of course they have their own rules to go by in Washington, and we must all abide by them, but it is rather unfortunate that they should be differently interpreted in different parts of the country and it seems to me most unfortunate that the shipbuilders have been

allowed to go to the front. The experience of England was that they had to take out of the trenches not only the shipyard workers but the ammunition workers and send them back to the factories again. It is a pity that we could not profit by that, but I suppose we will after we have gone a little further into the war. That would be a solution that would help very much with this laboring man difficulty. Of course the real trouble with the employers of labor is they are told that they must get together with the men and must have no trouble during this war; that they must keep the plant going. Every manager that I have talked with feels that it is incumbent on him as a good American to see that the wheels are kept going around and that these ships are produced, and I dare say that all the employers are perfectly willing that they should fight with their own laboring men and fight to a finish if need be, except at this time. We all know what that means. The demand is largely in excess of the supply of men. The sympathy of the Government is with the men. At our Navy Yard under the law we pay the going rate in that vicinity and arbitrarily fix the rate at a larger rate than the going rate in the vicinity which we have to meet, and we are told in case of difficulty we must keep going, so it is only a question that can be worked out by the Government's representatives and the shipyard employers together. I would be perfectly willing to see all the shipbuilders go down to the Navy Department and Shipping Board and say, "We will agree with you on these conditions and stand by them and will shut up our shop before we pay any more." Of course it can be said that a man who works is entitled to any wage he can get. Perhaps he is, but he is not entitled to stop working now, and he is not entitled to say that any other man shall not serve an apprenticeship now. He is not entitled to say that a helper shall not do a mechanic's work if he can do it. How perfectly ridiculous when a million and a half of the best young men that we have in the whole United States are serving an apprenticeship in the war, leaving their homes and going out to learn the art of soldiering in a very short time, and quite as difficult work to learn as riveting. What a ridiculous thing to say at a time like this that a man cannot get a job unless he has served his time at the trade, and tie the hands of the United States in this great war, which it must win if you and I are going to keep on being proud of living in the United States.

I was shown to-day in the case of a number of workers that the money which they could earn in a day was limited by the organization to which they belonged, and that if they earned that much money at two or three o'clock in the afternoon they would work no more, notwithstanding the fact that the management wanted them to do it. When will people ever learn that production by the use of labor-saving machinery to get a large production per man is all that gives us more than we ever would have otherwise or than we ever would have had before the days of large production? And yet they have limited production with the idea of giving more jobs to more men in

time of war when we have not got enough men and have about three jobs for one man!

I will take just a little bit of your time in presenting what I might say is the worker's side of the story. I do not know the conditions in Philadelphia, but I imagine they are rather bad for laboring men. As an instance of what can happen, in Newport News, a town ordinarily of 30,000 people, we now have 55,000 people. The place is so full of people that no one can even go there to see the soldiers off. The condition of laboring men who are gradually coming in from the West to all the seaboard towns is a very difficult one, and a great deal of the basis of discontent is a lack of suitable housing conditions. That is ordinarily taken care of in the towns and cities by real estate people and those who build for investment, but at the present time that method is wholly inadequate, and this question will have to be considered along with the same program as that for our Army which is being installed in cantonments all over the United States. Why? Because we cannot find vacant houses for 20,000, 30,000 or 40,000 men in any one place, and so quarters have to be provided the same as for the soldiers. This new population is fitted to do more work, to do shipbuilding and build munitions or guns, and it is therefore necessary that it be brought from elsewhere and be not literally dumped on a community already overcrowded, but that proper living conditions and houses be provided at once. The Government is waking up to this in the case of some recent contracts let for destroyers. The Government itself will finance the building of barracks or temporary hotels for the men, so that several hundred can be housed at or near the shipyards where the work is to be done. For instance, in Philadelphia you have large fabricated plants to be built, and you have a number of large war industries settled here. In addition, Essington will need probably 20,000 men and the fabricated shipyards probably 20,000 or 30,000 more. It becomes necessary even in this city, which is known all over the country as the best workmen's city in the United States, that the housing be looked into, and that large additional facilities be quickly provided. Men from the western part of this State will come here only by promise of decent homes where their wives and children may be properly cared for. That is a fairly simple thing, but it is a thing which has been neglected to an enormous extent, and one which will have to be rectified before we get far in the war program. One of the biggest problems England had was the formation of new communities and the building of whole towns. In some cases, they were almost ten miles square, and in them were provided not only ordinary houses and living accommodations, but public parks, playgrounds, theatres and everything needed in a modern town.

I had not intended to make a patriotic talk; it was supposed to be more or less of a technical talk, yet it all comes back to the question of men and willing men—willing to do work under conditions which their own Government and own representatives say are fair and

honorable both to the Government and to the men, and I say that if they will not work under conditions such as the Government specifies and at the rates of pay which the Government calls fair, then they should either be made to, or made to let alone men who are willing to do so.

I cannot imagine the United States letting stand in its way any band of men whatever when the National honor and National life, in fact, depends on our winning this war, and when we are sending forth our young men and boys by the thousands to France.

As a business man, I do not know of any man in the shipbuilding business who would care, and I, myself, do not care how much of my income the Government takes, so long as it treats everybody else the same, and so long as the business is left with enough money to carry on its operations and pay a most moderate return to the owner and be able to serve the Government in the best way. I do not care how much of the profit of the business they take, and I will go further than that. If it becomes necessary for the raising of money, a conscription of capital would not hurt my feelings at all. The importance of beating the Germans is so paramount that any or all of these methods may be used. The Chamber of Commerce of the United States at Atlantic City a very short time ago, representing many business men in the United States, gave voice to this sentiment: that if they treat us all alike they could not go too far in exacting the greatest toll from the business of the United States. We are willing, if necessary, to have the plants commandeered by the Government, under the terms of the United States and under conditions which they see fit to impose, but we do insist that managers, foremen, superintendents and men shall all be treated alike.

Any business man who has been to Washington has felt, I am sure, that unless he is very well acquainted he is apt to run around quite a little like a squirrel in a cage, without getting anywhere. I am not saying this in criticism of people in Washington, but we are doing so much new business that it is difficult to find the people with which to do business. I have been down there visiting the War Munitions Board and the Priority Committees, and those of us who are building ships or destroyers have a very difficult time in securing priority in getting material. We have received from the Navy Department and from the War Department and from the Shipping Board orders to proceed with the utmost vigor and despatch to do their work, each in the same tone of voice, each with equal authority, all vested in these various departments by Acts of Congress, so that actually what has happened is that the president of our Company has had to settle the question of priority himself—an entirely improper function for him. The question of priority and preference is now the biggest industrial question there is, for the very simple reason that the total production of the United States has been over-absorbed by these war activities.

With the prices settled, the only important thing is, who gets his first, who second and who third. We have

in the War Department six bureaus buying frequently in competition with each other. We have in the Navy Department five or six bureaus buying, or recommending to buy, not in competition with each other very much, but somewhat. In the Shipping Board we have a tremendous amount of buying going along more or less in competition with the War Department and the Navy Department. The Government simply wants to get the material in such quantities as it can, but it is simply impossible to satisfy all these Bureaus and Departments. What is the answer? The answer that has been found in Great Britain in the very first months of the war was to divorce the question of business, buying and price fixing from the naval and military activities of the country. A munitions minister was appointed; just the kind that we need. The same Chamber of Commerce I was speaking of recommended that a Board be appointed. I am a director in that Chamber, but I think a minister should be appointed, because you want a *man* who will coördinate the interests of the country, and when blankets are necessary he will buy blankets for the United States, and not buy three blankets for the sailors and none for the soldiers. In shipbuilding, in munitions production, and in arming and sending soldiers across to the other side, we have a great problem to meet. What have we in our country? We have great army cantonments. We have great army and navy orders from the Government and are competing day after day; we do not know who is first, second or third. I am sure that the Secretary of the Navy and the Secretary of War have both plenty to do to run the operations of their great Departments without working a large part of the time with the question of buying, and whether they are going to get this first, second or third. We have a Priority Committee, but they cannot settle it, but only recommend it. Actually, the best buying is done by the official who is the most zealous, so that we run great risk, if that keeps on, of having our soldiers on the other side with plenty of guns and muskets and maybe gunpowder, but not enough baked beans or peas or something that they need. It must be done in some way so as to least upset the country.

Another reason that business should go on as well as possible is because we have to earn some money somehow in order to meet the war taxes, and there is no need of disrupting it unnecessarily in buying in various ways. That has had a bad effect on the shipbuilding business.

The weakest point in the shipbuilding business is the forging situation, in my judgment. There are not enough forges in the United States to turn out all the forgings required for the shipbuilding. The great Bethlehem Company, Midvale, and the Allis-Chalmers are practically the only large ones we have, whereas Great Britain has twelve or fifteen very respectable forging concerns. It is

absolutely necessary that some one determine whether this or that or the other kind of forgings shall be first; otherwise a lot of us are apt to end up with hulls but no machinery in them. It seems to me that we all want to do the best we can, but we would very much appreciate it if we could go to Washington and say to some one that this is the most important, and that is the next, and that is the next. Instead of that, we appeal from one Department to another and frequently end up with nothing.

I am mentioning this to you because it is very much in my heart and mind; I see it in Washington every time I go there, and I hope very much that next winter when the question comes up in Congress they will see fit to do this instead of scattering the work among the Navy Department and the War Department and the Shipping Board.

I hope that all of the good people in Philadelphia will always maintain an open market for beginners in the shipbuilding industry, and when the Shipping Board works out its program of breaking in new men and bringing them in from the West, then every one in our business will do their best to give a helping hand. We invited the Board to bring its school to Newport News. I think they have been invited by one or two Delaware shipyards to establish a school for the instruction of teachers who would go back to their home yards to break in all of the new help. We have to break in large numbers of new men, and the most important question next to the housing question is the breaking in of these new men, and our foremen and superintendents must get used to the honor of subjecting themselves to the discomfort and inconvenience and annoyance of breaking in large numbers of perfectly green, raw country boys.

We all know that it is a joy to have a few good mechanics and give them a job and forget about it, but we have to get away from that and to teach new people, which may fortunately be done with ships of standard make and duplicate makes. The biggest problem that the employment managers have at the present time is to get hold of the best material possible, house it as decently as we can, and teach it shipbuilding as quickly as possible. The problem almost dazes one to contemplate. It can only be solved by bringing in enormous quantities of new men, and which must be done without any hindrance. The leaders of the unions have stated that they would allow this to be done. We have to do it, and no matter what else happens we must insist upon the right to break in any number of new men in the business. The Shipping Board will back it up, and I am sure that sooner or later the Administration itself will insist upon that being done on such a comprehensive scale as to make it possible for the United States to carry out its great shipbuilding program, which *must* be carried out.

ELECTRIC CODE*

ADOPTED BY THE INDUSTRIAL BOARD
PENNSYLVANIA DEPARTMENT OF LABOR AND INDUSTRY
OPERATIVE ON AND AFTER JULY 1, 1917

(Concluded from page 493, October issue)

SCOPE

The safety rules in 210-54 apply to the operation of, and work on or about, supply lines and signal lines used in connection therewith, and to the operation of and work on or about the electrical equipment of central stations, substations, private plants, and on or about electrical tests, and tunnel, subway, or similar underground work. They do not apply to new construction, which has not been made available for regular service.

While all the rules find application in the larger industrial or private plants and in moderate-sized utilities, some do not apply (or apply less fully) in the smaller. It has seemed unwise, however, to attempt to restrict the scope of these rules to rules which are applicable to all organizations or to all classes of electrical work.

The safety rules in rules 55-58 apply to commercial telephone, telegraph, and other signal equipment and lines, with terminology adapted to the special needs of the employees concerned.

RULES FOR THE EMPLOYER

Organization

400. Interpretation and Enforcement of Rules

(a) The employer shall furnish to each regular employee operating or working on electrical supply equipment, supply or signal lines, or hazardous electrical tests, a copy of these safety rules for operation (or such of these rules as apply to his work), either separately or incorporated in more comprehensive rule books, and shall take means to secure the employee's compliance with the same.

(b) If a difference of opinion arises with regard to the meaning of application of these rules, or as to the means necessary to carry them out, the decision of the employer or his authorized agent shall be final, subject to an appeal (if taken) to the regulative body having jurisdiction.

(c) Cases may arise where the strict enforcement of some particular rule will seriously impede the progress of the work in hand; in such cases the employee in charge of the work to be done and the employee in charge of that portion of the system on which the work is to be done may, with the consent of the chief operator concerned, make such temporary modification of the rule as will expedite the work without materially increasing the hazard.

* NOTE.—Printed by courtesy of John Price Jackson, Chairman, Industrial Board.

(d) Many companies number their books of rules and require a receipt from each employee for his copy.

401. Organization Diagram

To better secure the safe and accurate performance of work, an organization diagram or written statement clearly showing the division of responsibility between officials and employees, down to and including the grade of foreman, should be supplied with the book of rules, or the rules should be posted conspicuously in offices and stations of the employer and in other places where the number of employees and the nature of the work warrant.

402. Address List and Emergency Rules

The rule book should contain or be accompanied by the following:

A list of names and addresses of those physicians of the organization who are to be called upon in emergencies.

A copy of rules for first-aid, resuscitation, and fire extinguishment.

These should also be kept in conspicuous locations in every station and testing room, in line wagons, and in other places where the number of employees and the nature of the work warrant.

403. Instructing Employees

Employees regularly working on or about equipment or lines shall be thoroly instructed in methods of first-aid, resuscitation, and where advisable in fire extinguishment.

404. Qualifications of Employees

The employer shall use every reasonable means and precaution to assure himself that each employee is mentally and physically qualified to perform his work in accordance with these rules.

405. Chief Operator

(a) A properly qualified chief operator system operator, load dispatcher, general superintendent, or otherwise designated employee, whose duties shall be those prescribed in rule 430, shall be in charge of the operation of electrical equipment and lines and directly responsible for their safe operation.

(b) In large organizations the duties of the chief operator may be delegated for any particular section of the system to a deputy chief operator (or otherwise designated employee) who shall report as required to the chief.

(c) When it is impracticable to have the entire system placed in charge of one chief operator, the duties of the chief operator may be performed for a portion of the system by a local superintendent, local manager, or other employee who may also perform other duties.

(d) In small organizations the duties of the chief operator may be performed by the superintendent, electrician, engineer, or some other employee who may also perform other duties.

In these rules, the various employees listed by the above titles, including the deputy chief operator, will be designated (for simplicity) by the title of chief operator, where referred to in this capacity.

406. Responsibility

If more than one person is engaged in work on or about the same electrical equipment or lines at any one location, one of the persons shall be designated as the foreman locally in charge of the work; or all of the workmen shall be instructed as to the work they are to perform, and the employee instructing the workmen shall be considered in charge of the work.

PROTECTIVE METHODS AND DEVICES

410. Attendance

Unless a qualified employee is kept on duty where generators or rotary converters are operating, such equipment shall be made inaccessible to unauthorized persons.

411. Requirement for Two Workmen

Except in trouble or emergency work, at least two employees should be provided where work is done on live lines above 750 volts in wet weather or at night.

412. Uninstructed Workmen and Visitors

Unqualified employees or visitors shall be prohibited from approaching any live parts, unless accompanied by a qualified employee.

413. Diagrams for Chief Operator

Diagrams or equivalent devices, showing plainly the arrangement and location of the electrical equipment and lines, should be maintained on file or in sight of the chief operator.

These diagrams may be of the entire system, of each specific portion of the system, or they may show typical arrangements.

414. Instructions to Employees

All employees shall be instructed as to the character of all equipment or lines on, or dangerously near to, which work must be done by them.

Instructions shall describe the equipment and lines to be worked on, identifying them by position, letter, color, number, or name.

415. Protective Devices

There shall be provided in conspicuous and suitable places in electrical stations, testing departments, and line construction and repair wagons a sufficient supply of suit-

able protective, first-aid, and fire-extinguishing devices and equipment, to enable employees to meet the requirements of these rules. Such devices and equipment shall be inspected or tested to insure that they are kept in good order. The following is a list of suitable devices and equipment, the kinds and numbers of which will depend on the requirements of each case:

(1) First-aid outfits.

(2) Insulating wearing apparel, such as insulating gloves, sleeves, and boots. Insulating shields, covers, mats, stools, and platforms. Insulating appliances, such as rods and tongs, for any necessary handling or testing of live equipment or lines.

(3) Protective goggles of suitable materials and construction.

(4) Tools of such special design and insulation as to eliminate so far as practicable the danger of forming short circuits across conducting parts at different potentials or bringing the user into circuit with such parts.

(5) "Men at work" tags, log books, operating diagrams or equivalent devices, and portable danger signs.

(6) Fire-extinguishing devices, either designed for safe use on live parts or plainly marked that they must not be so used.

(7) Grounding devices for making protective grounds.

Safety belts, whether furnished by employer or employee, should be inspected from time to time to assure that they are in safe working condition.

416. Warning and Danger Signs

There shall be displayed in conspicuous places at all unattended and unlocked entrances to electrical supply stations, substations, and testing rooms containing exposed current-carrying parts or moving parts, permanent warning signs forbidding entrance to unauthorized persons.

Suitable danger signs shall be placed in supply stations, substations, switching towers, and testing rooms about equipment having exposed current-carrying parts above 750 volts.

GENERAL RULES FOR THE EMPLOYEE

General Precautions

420. Rules and Emergency Methods

The safety rules should be carefully read and studied. Employees may be called upon at any time to show their knowledge of the rules.

Employees should familiarize themselves with approved methods of first-aid, resuscitation, and fire extinguishment.

421. Heeding Warnings, Warning Others

Employees whose duties do not require them to approach or handle electrical equipment and lines should keep away from such equipment or lines.

They should cultivate the habit of being cautious, heeding warning signs and signals, and always warning others when seen in danger near live equipment or lines.

422. Inexperienced or Unfit Employees

No employee shall do work for which he is not properly qualified on or about live equipment or lines, except under the direct supervision of an experienced and properly qualified person.

423. Supervision of Workmen

Workmen whose employment incidentally brings them in the neighborhood of electrical supply equipment or lines with the dangers of which they are not familiar shall proceed with their work only when authorized. They shall then be accompanied by a properly qualified and authorized person, whose instructions shall be strictly obeyed.

424. Exercising Care

Employees about live equipment and lines should consider the effect of each act and do nothing which may endanger themselves or others. Employees should be careful always to place themselves in a safe and secure position and to avoid slipping, stumbling, or moving backward against live parts. The care exercised by others should not be relied upon for protection.

425. Live and Arcing Parts

(a) *Treat Everything as Alive.*—Electrical equipment and lines should always be considered as alive, unless they are positively known to be dead. Before starting to work, preliminary inspection or test should always be made to determine what conditions exist. (See rules 440 and 461.)

(b) *Protection Against Arcs.*—If exposed to injurious arcing, the hands should be protected by insulating gloves and the eyes by suitable goggles or other means.

Employees should keep all parts of their bodies as distant as possible from brushes, commutators, switches, circuit breakers, or other parts at which arcing is liable to occur during operation or handling.

426. Safety Appliances and Suitable Clothing

(a) *Safety Appliances.*—Employees at work on or near live parts should use the protective devices and the special tools provided, first examining them to make sure that these devices and tools are suitable and in good condition. Protective devices may get out of order or be unsuited to the work in hand.

(b) *Suitable Clothing.*—Employees should wear suitable clothing while working on or about live equipment and lines. In particular they should keep sleeves down and avoid wearing unnecessary metal or inflammable articles, such as rings, watch or key chains, or metal cap visors, celluloid collars or celluloid cap visors. Loose clothing and shoes that slip easily should not be worn near moving parts.

427. Safe Supports and Safety Belts

(a) *Safe Supports.*—Employees should not support themselves on any portion of a tree, pole structure, scaffold, ladder, or other elevated structure without first making sure that the supports are strong enough, reinforcing them if necessary.

Portable ladders should be in a safe position before being climbed. The slipping of a ladder at either end should be carefully guarded against, especially where the surfaces are smooth or vibrating.

(b) *Safety Belts.*—Employees should not work in elevated positions unless secured from falling by a suitable safety belt or by other adequate means. Before an employee trusts his weight to the belt, he should determine that the snaps or fastenings are properly engaged and that he is secure in his belt. Any employee who furnishes his own belt shall from time to time submit it to his employer for inspection.

428. Fire Extinguishers

Employees should avoid using fire-extinguishing liquids which are not insulating in fighting fires near exposed live parts. If necessary to use them, all neighboring equipment should first be killed. (See section 45.)

429. Repeating Messages

To avoid misunderstandings and to prevent accidents, each person receiving an unwritten message concerning the handling of lines and equipment shall immediately repeat it back to the sender and secure his full name and acknowledgment. Each person sending an unwritten message shall require it to be repeated back to him by the receiver and secure the latter's full name.

GENERAL OPERATION**430. Duties of Chief Operator**

The chief operator, described in rule 405, shall keep informed of all conditions affecting the safe and reliable operation of the system, and shall keep a suitable record or log book showing all changes in such conditions. He shall read and sign such record when assuming duty and sign again on being relieved. He shall keep within sight operating diagrams or equivalent devices indicating whether electrical supply circuits are open or closed at stations under his immediate jurisdiction and where work is being done under his special authorization, provided that these devices shall not be required for any chief operators classed under paragraphs (c) and (d) of rule 405 if the record or log sheets show these conditions.

His further duties will vary according to the size and character of the system under his jurisdiction, and might, for example, be about as follows:

(1) In the case of distribution from a single station, he shall direct the starting and stopping of generating equipment and the opening and closing of outgoing cir-

cuits. He shall, in general, give permission for work to be done on live lines above 7500 volts and in all cases where circuits are killed at the station for the protection of workmen.

(2) In the case of a system consisting of one or more generating stations and a number of substations, he shall have supervisory charge within his jurisdiction of the operation of all generating and substation equipment and direct charge of interconnected transmission and feeder lines, and where protection of workmen is concerned, shall direct the starting and stopping of generating and substation equipment. He shall, in general, give permission for work on live lines above 7500 volts and on live interconnected lines, and in all cases where circuits are killed at the generating stations for the protection of workmen.

In these rules the person performing these duties is designated as chief operator, regardless of his ordinary title.

431. Duties of Foreman

(a) Each foreman in charge of work shall adopt such precautions as are within his power to prevent accidents and to see that the safety rules are observed by the employees under his directions. He shall make all the necessary records, reporting to his chief operator when required. He shall, as far as possible, prevent unauthorized persons from approaching places where work is being done. He shall also prohibit the use of any tools or devices unsuited to the work in hand or which are so defective or in such poor condition as to make them unsafe.

(b) The qualified persons accompanying uninstructed workmen or visitors near electrical equipment or lines shall take precautions to provide suitable safeguards and see that the safety rules are observed.

432. Special Authorizations

(a) *Special Work.*—Special authorization from the chief operator shall be secured before work is begun on or about station equipment, transmission, or interconnected feeder lines or live lines above 7500 volts, and in all cases where lines are to be killed by regular procedure (see section 45) at stations, and a report shall be made to him when such work ceases.

Exceptions.—In emergency, to protect life or property, or when communication with the chief operator is difficult, due to storms or other causes, any qualified employee may make repairs on or about the equipment or lines covered by this rule without special authorization if the trouble is such as he can promptly clear with help available in compliance with the remaining rules. The chief operator shall thereafter be notified as soon as possible of the action taken. (See rule 436 (b).)

(b) *Operations at Stations.*—In the absence of specific operating schedules for opening and closing supply circuits at stations, or starting and stopping equipment, employees shall secure special authorization from the chief operator before performing these operations. In all cases such special authorization shall be secured where circuit

or equipment control devices are tagged at stations to protect workmen. (See rule 435.)

Exceptions.—In emergency, to protect life or property, any qualified employee may open circuits and stop moving equipment without special authorization if, in his judgment, his action will promote safety, but the chief operator shall be notified as soon as possible of such action, with reasons therefor. To maintain service, any qualified employee may also reclose circuits which have been opened by automatic cut-outs, except where this is prohibited by rule 434.

(c) *Cutting Out Sections of Circuits.*—Special authorization shall be secured from the chief operator before sections of overhead or underground circuits are cut off by employees at points other than at stations by means of sectionalizing switches.

Exception.—Portions of distribution circuits below 7500 volts may be cut off by authorized employees, without special authorization from the chief operator, by means of sectionalizing switches, if the chief operator is thereafter notified as soon as possible of the action taken. This may also be done even for circuits above 7500 volts when communication with the chief operator is difficult.

433. Restoring Service After Work

No instructions for making alive equipment or lines which have been killed by permission of the chief operator to protect workmen shall be issued by him until all workmen concerned have been reported clear. When there is more than one workman at a location, a person authorized for the purpose shall report clear for such workmen, but only after all have reported clear to him. If there is more than one gang, each shall be so reported clear to the chief operator.

434. Maintaining Service

(a) When live circuits on which "Men at work" tags have been placed are opened automatically, they should be kept disconnected until the chief operator has given proper authorization for reconnection.

(b) When overhead circuits other than trolley and third-rail circuits open automatically, the employer's local operating rules shall determine in what manner and how many times they may be closed with safety for persons on or near those circuits. The chief operator shall be advised of the conditions.

(c) When circuits feeding supply lines become accidentally grounded, they shall be tested to determine where the ground exists. If the ground cannot be definitely located and removed by the station operator, an immediate report of the finding shall be given to the chief operator, who shall order a patrol of the lines affected to definitely locate and remove the ground as soon as practicable.

Above 7500 volts it will usually be found advisable to disconnect the circuit or effectively ground the accidentally grounded conductor until the lines have been cleared of the accidental ground.

435. Tagging Electrical Supply Circuits

Before work is done under special authorization of the chief operator on or about any equipment or lines used as transmission or interconnected feeder lines, or lines operating above 7500 volts, or lines killed at stations or substations to protect workmen, the chief operator shall have "Men at work" tags attached at all points where such equipment or lines can be manually controlled by regular operators to plainly identify the circuits worked on.

Before work is done on or about any equipment or lines which are killed by authorized employees at points other than at stations, the employees shall have "Men at work" tags placed at all points where the circuit has been disconnected to identify the portion worked on.

436. Protecting Traffic

(a) *Barrier Guards*.—Before engaging in such work as may endanger traffic, employees shall first erect suitable barrier guards. They shall also display danger signs or red lamps from two sides of the barriers at right angles to the direction of the traffic. Where the nature of work and traffic requires it, a man shall be stationed to warn passers-by while work is going on.

(b) *Crossed or Fallen Wires*.—When any crossed or fallen wires which may create a hazard are found, the employee shall remain on guard or adopt other adequate means to prevent accidents and have the chief operator notified. If the employee can observe the rules for handling live parts by the use of insulating appliances, he may correct the condition at once. Otherwise he shall first secure the authorization from the chief operator for so doing. (See rule 432 (a).)

437. Protecting Workmen by Disconnectors

When equipment or lines are to be discontinued from any source of electrical energy, for the protection of workmen, the operator shall first open the switches or circuit breakers designed for operation under load, and then the air-brake disconnectors, when provided.

HANDLING LIVE EQUIPMENT AND LINES

In all these operating rules "voltage" means in general the highest effective voltage between the conductors of the circuit concerned, except that in grounded multi-wire circuits, not exceeding 750 volts between outer conductors, it means the highest effective voltage between any wire of the circuit and the ground.

In ungrounded low-voltage circuits, "voltage to ground" means in these rules the voltage of the circuit.

When one circuit is directly connected to another circuit of higher voltage (as in the case of an autotransformer), both are considered as of the higher voltage, unless the circuit of the lower voltage is permanently grounded. Direct connection implies electrical connection as opposed to connection merely thru electromagnetic or electrostatic induction.

Signal equipment and lines not over 400 volts are not considered alive, except where made alive by leakage from supply equipment or lines. They are, however, a source of danger when near live supply lines, due to their liability of being grounded.

440. General Requirements

(a) *Touching Live Parts*.—No employee should touch with bare hands at the same time two parts at different potential; nor should he touch with bare hands even a single exposed ungrounded live part at a dangerous potential to ground unless he is insulated from other conducting surfaces, including the ground itself, and stands on insulating surfaces.

(b) *Wire Insulation*.—Employees should not place dependence for their safety on the insulating covering of wires.

All precautions in this section for handling live parts shall be observed in handling insulated wires.

Insulation on a wire may look perfect, but it frequently cannot be relied on to prevent shock.

(c) *Exposure to Higher Voltages*.—Every employee working on or about equipment or lines exposed in overhead construction to voltages higher than those guarded against by the safety appliances provided should as far as practicable assure himself that the equipment or lines worked on are free from dangerous leakage or induction or have been effectively grounded.

(d) *Cutting Into Insulating Coverings of Live Conductors*.—When the insulating covering on live wires or cables must be cut into, the employee should use a suitable tool. While doing such work it is recommended that suitable goggles be worn to protect the eyes and insulating gloves to protect the hands.

When metal sheathing must be removed from cables it should be done with special tools which will not injure the insulation. The sheathing should be so cut as to leave enough exposed insulation after the conductor has been bared to avoid arcing over between the conductor and the sheath. If the cable consist of more than one conductor, similar exposed insulating surfaces should be left for each conductor, using insulating separators between conductors, if necessary.

Insulating devices, such as wood separators, etc., should be examined to eliminate conducting dust or chips, sharp edges or nails, which may defeat the purpose for which the devices are intended.

441. Voltages Between 750 and 7500

No employee should go or take any conducting object within six inches of any exposed live part whose voltage exceeds 750, in stations, testing rooms, in underground construction, or in overhead construction, where it is practicable to avoid this, except as follows:

(a) In dry locations this distance may be less than six inches, if insulating devices, such as shields, covers, or gloves, are placed between the person and the part or object.

The distance may also be reduced if insulating barriers (such as mats, stools, or platforms) are placed between the person and the ground, and suitable insulating shields between the person and all other conducting surfaces, except the live part, which he could accidentally touch at the same time.

(b) In all damp or dark locations, and whenever grounded surfaces are exposed, the distance may be less than six inches only if insulating devices are used between the person and the live parts and also between him and all other conducting surfaces with which he might otherwise come in contact at the same time.

Where safe distance from live parts cannot be secured by use of the special insulating tools and appliances furnished, properly tested insulating gloves and sleeves may serve as the sole portable insulating devices between the person and live parts.

Care should be exercised in using insulating gloves to avoid puncturing them on sharp edges, especially in making wire splices. It is sometimes advisable to wear protecting gloves over insulating gloves.

442. Voltages Above 750

No employee should go, or take any conducting object, within the distance named below from any exposed live part at or above the voltage specified, except as permitted by this rule:

Operating voltage:	Distance in feet
7,500	1
15,000	2
50,000	3
70,000	5

Distances for intermediate voltage to be determined by interpolation.

(a) In dry locations these distances may be reduced, if suitable insulating guards or barriers are placed between the person and such part of object.

(b) If the part is being directly worked on, the tools or other mechanical appliances used shall provide the full distance of insulating material, unless protective guards are also used between the person and the live part. These protective guards may be permanent insulating covers or shields, or may be disks of insulating material, suitable for the voltages to be handled and for the attendant conditions, attached to the handles of rods or tools.

443. Requirement for Two Workmen

Except in trouble and emergency work, no employee shall work alone dangerously near live lines above 750 volts in wet weather or at night.

444. When to Kill Parts

No employee shall approach or willingly permit others to approach any exposed underground part normally alive, except as provided in rules 440, 441, and 442 of this section, unless he has first assured himself of his own safety and the safety of those working under his direction by having the supply equipment and lines killed. (See section 45.)

445. Operating Switches and Working from Below

(a) *Opening and Closing Switches.*—Manual switches and disconnectors should always be closed by a single unhesitating motion, and, if possible, with one hand. Care should be exercised in opening switches to avoid causing serious arcing.

(b) *Work from Below.*—Employees should avoid working on equipment or lines from any position by reason of which a shock or slip will tend to bring the body toward exposed live parts. Work should therefore generally be done from below, rather than from above.

446. Attaching Connecting Wires and Grounds

(a) *Handling Connecting Lines.*—In connecting dead equipment or lines to a live circuit by means of a connecting wire or device, employees should first attach the wire to the dead part before attaching it to the circuit. When disconnecting, the live end should be removed first.

Loose conductors shall be kept away from exposed live parts.

Metal measuring tapes, and tapes, ropes or hand lines having metal threads woven into the fabric, should not be used near exposed live parts.

Ladders reinforced by metal in a longitudinal direction should not be used near exposed live parts.

(b) *Applying Grounds.*—In applying a grounding device to normally live parts the device shall be grounded before being brought near the parts, and shall be removed from the live parts before being removed from the ground connection.

447. Handling Series Circuits

Secondaries of current transformers to meters or other devices should not be opened when alive, until a jumper has been connected across the point of opening or said secondary has been short-circuited elsewhere.

Before working on arc lights or similar devices connected to series circuits they shall be short-circuited, or (when necessary to avoid hazard) disconnected entirely from such circuits by absolute cut-outs.

448. Stringing Wires

In stringing wires near live conductors, they should be treated as alive unless it is effectively grounded.

KILLING SUPPLY EQUIPMENT AND LINES

Where workmen must depend on others for operating switches to kill circuits on which they are to work, or must secure special authorization from the chief operator be-

fore themselves operating such switches, the following precautionary measures shall be taken in the order given, before work is begun on or about the equipment or lines concerned, as a means for preventing misunderstanding and accident.

In small organizations the chief operator may himself operate the switches and disconnectors instead of instructing others to do so, thus much simplifying and abbreviating the procedure. In certain cases the chief operator may direct the workman who wishes the section killed for his own protection, to operate some or all switches necessary himself, thus also abbreviating the procedure.

In cases where there is no station with regular attendants at either end of a section of line to be killed for the protection of workers, the rules below need not apply for disconnection of that end of the section concerned, provided that the employee under whose direction that end of the section is disconnected is in sole charge of the section and of the means of disconnection employed or that the point of disconnection at that end of the section is suitably tagged before work proceeds.

450. Workman's Request

The workman in charge of the work shall apply to the chief operator to have the particular section of equipment or lines killed, identifying it by position, letter, color, number, or other means.

451. Opening Disconnectors and Tagging

The chief operator at his discretion shall direct the proper persons to open all switches and air-break disconnectors thru which electrical energy may be supplied to the particular section of equipment and lines to be killed and shall require such person to tag such switches and disconnectors, and each tag shall be of a distinctive character indicating that men are at work. All oil switches and remotely controlled switches should also be blocked where necessary for avoiding mistakes.

The person shall, when placing the tag, record the time of disconnection, his own name, the name of the workman who requested the disconnection, and the name of the chief operator.

Where the section of equipment or lines can be made alive from two or more sources, all such sources shall be disconnected. This will apply to work on lines with more than one station, also sometimes to work on transformers in banks, rotary converters, motor generators, switches, and on other similar equipment.

452. Station Protective Grounds

When all the switches and disconnectors designated have been opened, blocked, and tagged in accordance with rule 451 the chief operator shall require each person operating them to make protective grounds (see section 46) upon the lines being killed and to report to him when such grounds are in place.

453. Permission to Work

Upon receipt of information from all persons operating switches and disconnectors that protective grounds are in place the chief operator shall advise the workman who requested the killing of the section that the specified section of equipment or lines has been killed and that he may proceed to work.

454. Workmen's Protective Grounds for Overhead Lines

The workman in charge should immediately proceed to make his own protective grounds on the disconnected lines, except under conditions where the making of such ground will itself be more hazardous than working on the lines without grounding. Such grounds shall be made between the particular point at which work is to be done and every source of energy.

455. Proceeding with Work

After the equipment or lines have been killed (and grounded, if required by rule 454) the workman in charge and those under his direction may proceed with work without taking the precautions required on or about live parts by these rules.

456. Procedure for Other Gangs

Each additional workman in charge desiring the same equipment or lines to be killed for the protection of himself or the men under his direction shall follow the same procedure as the first workman and secure similar protection.

457. Reporting Clear—Transferring Responsibility

The workman in charge, upon completion of his work, and after assuring himself that all men under his direction are in safe positions, shall remove his protective grounds and shall report to the chief operator that all tags protecting him may be removed, and shall give his location and report as follows: "Mr. ——— and men clear and all grounds removed."

The workman in charge who received the permission to work may transfer this permission and the responsibility for men under him, as follows:

He shall personally inform the chief operator of the proposed transfer, and if this is permitted, the name of the successor shall be entered at that time on the tags concerned or in the records of the persons placing the tags and of the chief operator. Thereafter the successor shall report clear and shall be responsible for the safety of the original workmen, so far as this is affected by the removal of tags.

458. Removal of Tags

The chief operator shall then direct the removal of tags for that workman and the removal shall be reported back to him immediately by the persons removing them.

Upon the removal of any tag, there shall be added to the record the name of the chief operator and workman who requested the tag, the time of removal, and the signature of the person removing the tag.

459. Restoring Service

Only after all protecting tags have been removed by the above procedure from all points of disconnection shall the chief operator at his discretion, direct the removal of protective grounds and blocks and the closing of any or all switches and disconnectors.

MAKING PROTECTIVE GROUNDS

When making temporary protective grounds on a normally live circuit the following precautionary measures shall be observed in the order given, and the ground shall be made to all wires of the circuit, which are to be considered as grounded:

460. Ground Connections

The employee making a protective ground on equipment or lines shall first connect one end of grounding device to an effective ground connection supplied for the purpose.

461. Test of Circuit

The normally live parts which are to be grounded should next be tested for any indication of voltage, the employee carefully keeping all portions of his body at the distance required from such parts when alive by the use of suitable insulating rods or handles of proper length, or other suitable devices.

462. Completing Grounds

If the test shows no voltage, or the local operating rules so direct, the free end of the grounding device shall next be brought into contact with the normally live part and securely clamped or otherwise secured thereto, before the employee comes within the distances from the normally live parts specified in rules 441 and 442, or proceeds to work upon the parts as upon a grounded part.

In stations, remote control switches can sometimes be employed to connect the equipment or lines being grounded to the actual ground connection. On lines it is generally necessary to resort to portable grounding devices or chains handled directly by means of insulating handles, rods, or ropes.

463. Removing Grounds

In removing a protective ground the employee shall not remove the grounding device from the ground connection until the device has been disconnected from all normally live current-carrying parts.

SPECIAL RULES FOR EMPLOYEES

Supply Station and Switchboard Operation

Engineers, machine attendants, switchboard operators and helpers shall study and strictly observe the following, in addition to all the general rules in sections 42 to 46, which apply to their work:

470. Care About Machines

Do not allow oil cans, tools, dusters, or wiping cloths to catch in moving parts of machinery. In passing any switchboard or machine in operation, do not touch it unnecessarily nor allow metal tools or other metal objects to touch the apparatus or connections. Do not use iron or tin oil cans near field magnets, and use only dusters and wipers with insulating handles on or about exposed live parts.

Any employee about to work on normally moving parts of electrical equipment during periods of rest shall protect himself against their accidental starting by placing "Men at work" signs on the starting devices, and locking or blocking these where practicable.

471. Care About Live or Moving Parts

Do not work on or near exposed live or moving parts unless authorized to do such work, and then strictly observe the rules applying.

When working near fuses and circuit breakers or other apparatus which may arc suddenly, be careful to avoid injury from their operation.

When working on one section of a switchboard or in one compartment, mark it conspicuously and place barriers to prevent your accidental contact with live parts in that section or adjacent sections.

When working on or about live parts and standing on insulated stools or ladders, or when otherwise insulated from the ground, avoid handling metal tools or other objects to other persons who are not insulated.

472. Handling Fuses or Brushes

In handling fuses above 750 volts, use the special rods or tongs and stand on insulating platforms, or mats, where provided. Keep the body as distant and as far below as possible.

Replace or remove link fuses from live terminals and handle brushes on live equipment only when absolutely necessary, and then with due precautions.

473. Battery Rooms

Do not smoke or cause arcing in storage battery rooms. The use of open flames should be avoided, especially while the cells are gassing, and should be permitted only in special cases under the direct supervision of an experienced person, and after the room has been thoroly ventilated.

Do not handle live parts of batteries or their connections, unless standing on insulating platforms or wearing suitable insulating boots.

474. Working in Elevated Positions

When working in an elevated position, especially above live or moving parts, assure yourself of the security of your position and support, and take precautions to avoid dropping tools or materials.

475. Handling Switchboard Equipment

All ungrounded metal parts of devices on switchboards shall be handled as if operating at the highest voltage to which any portion of the equipment on the same switchboard panel is subject, unless the parts are known, by test or otherwise, to be free from such voltage.

When cable plug connectors are used, do not allow one end to remain hanging loose while the other end is connected to alive terminal.

In handling instrument circuits, the secondary of a current transformer should never be opened when it is alive.

476. Reporting Circuit Trouble to Chief Operator

Report to your immediate superior or to the chief operator any unusual conditions of load, and the indication of any accidental ground on an outgoing circuit.

477. Reporting Defects

Promptly report to your superior any dangerous conditions of equipment or surroundings, including defective tools, switches, or protective devices, or live cases or frames of apparatus or instruments.

Overhead Line Operation

Linemen and assistants and groundmen, in construction, extension, removal, or repair work, shall study and strictly observe the following, as well as all the general rules in sections 42 to 46 which apply to their work.

480. Testing Structures Before Climbing

Before climbing poles, ladders, scaffolds, or other elevated structures, first assure yourself that the pole, ladder, scaffold, tree, cross arm, messenger wire, cable car, or boatswain's chair, or other elevated support, is strong enough to safely sustain your weight.

Poles may be tested for decay near the ground line with a bar, screw driver, or other tool, and sounded for decay at the center by rapping with a heavy tool or block of wood.

When poles or cross arms are apparently unsafe from decay or unequal strains of wire on them they should be properly braced or guyed, if necessary, before they are climbed.

481. Use of Poles Steps

When poles are stepped, make use of such steps in climbing.

Do not support yourself by pins, brackets, or conductors.

482. Spurs

Spurs with gaffs worn short shall not be used. The gaff on spurs shall be kept sharp, and spurs shall fit properly. Spurs shall not be worn on work for which they are not required, nor while men are travelling to or from work.

483. Care About Live Parts

Do not go among any wires until you know their voltage.

Leaning over and crowding through unprotected wires should be avoided wherever possible. Place yourself so that you will not be liable to fall on wires should an accident occur.

Do not depend on the insulating covering of wires, and treat all lines as alive unless they have been properly killed (except signal lines known to be clear).

Avoid use of hand lines or measuring tapes containing metal strands.

In handling dangerous switches or fuses do so only by means of suitable insulating handles, rods, or tongs.

484. When Touching Live Parts

When working on live equipment or lines never allow any portion of the body to come in contact with any live or grounded part other than that worked on.

While touching supply lines or equipment, avoid as far as possible touching ground wires, guy wires, span wires, metal pipes, metal poles, metal sheaths, signal lines or equipment, transformer cases, hangers, and other metal fixtures.

Signal lines are included principally because of their liability of being grounded.

The other equipment and lines listed may become either alive or grounded.

While touching signal lines or equipment, metal sheaths, metal pipes, ground wires, or metal fixtures on poles, avoid as far as possible touching supply lines or equipment, guy or span wires.

485. Protecting Traffic

When working overhead, keep tools and materials not in use in proper receptacles; tools or materials should not be thrown to or from the man on the pole, but should be raised or lowered by means of a hand line, using proper receptacle where practicable.

Do not unnecessarily stand where you can be struck by materials dropped by men working overhead.

Pole holes and obstructions along public highways and other frequented places shall be protected by watchmen or by suitable guards or danger signals so located as to be conspicuous to traffic.

When working overhead, or hoisting or lowering materials above places where frequent traffic occurs, a man should be stationed to warn passers-by.

Where traffic is light, warning signs or barriers may be used in lieu of watchmen. Where traffic is congested, it may be necessary to rope off the space.

486. Stringing Lines

Never string wire near live lines except by means of suitable insulating hand lines or other appliances. Avoid bringing them in contact with the live lines. Regard

(Continued on Page 539)

ENGINEERS' CLUB OF PHILADELPHIA

OFFICERS AND DIRECTORS, 1917

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SECRETARY

H. A. STOCKLY

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J. FRANKLIN STEVENS

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J. H. M. ANDREWS
WM. C. L. EGLIN

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EMMETT B. CARTER

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A. H. EHLE (S. A. E.)
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D. ROBERT YARNALL
J. C. WAGNER

W. C. L. EGLIN
J. H. M. ANDREWS
H. A. STOCKLY, Sec'y of Comm.

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EDGAR MARBURG EDWIN F. SMITH

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CARL HERING
W. P. TAYLOR
W. J. SERRILL
W. P. DALLETT
F. C. DUNLAP
STAUNTON B. PECK

MEETINGS

R. H. FERNALD, Chairman (E. C.)
L. H. KENNEY (E. C.)
A. J. ROWLAND (I. E. S.)
J. A. STEINMETZ (A. S. M. E.)
W. L. STEVENSON (A. S. C. E.)
W. P. DALLETT (W. T. C.)
H. A. TERRELL (M. I. T.)
N. S. PRINGLE (S. A. E.)
GEORGE BOON (A. S. H. & V. E.)

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GEORGE R. HENDERSON, Chairman (E. C.)
EMMETT B. CARTER (E. C.)
FRED. C. DUNLAP (A. S. C. E.)
H. L. MOODY (M. I. T.)
W. H. PALMER, JR. (S. A. E.)
THOMAS SPROULE (I. E. S.)
S. L. KNEASS (A. S. M. E.)
GEO. A. DENNY (W. T. C.)
JOHN D. CASSELL (A. S. H. & V. E.)
H. F. SANVILLE (A. I. E. E.)

PAPERS

LEWIS H. KENNEY, Chairman
R. H. FERNALD
W. POOL PARKER
H. P. GANT
G. M. SPEAR
W. M. BOEHM
H. F. SANVILLE
L. P. KELLOGG
J. A. STEINMETZ

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D. ROBT. YARNALL, Chairman
H. GOODWIN, JR. R. H. FERNALD
A. W. BARTLETT A. C. WOOD

TELLERS

GEO. E. CROFOOT, Chairman
JOHN P. MUDD CHAS. F. PUFF
HAROLD GOODWIN, JR. JOHN S. ELY

BY-LAWS

J. F. STEVENS, Chairman
R. H. FERNALD J. C. TRAUTWINE, JR.
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LEWIS H. KENNEY
WM. C. L. EGLIN
S. M. SWAAB
J. F. STEVENS

INCREASE OF MEMBERSHIP

CLAYTON W. PIKE, Chairman
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J. E. GIBSON
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BUILDING

S. M. SWAAB, Chairman
F. C. DUNLAP
H. P. GANT
J. F. MURRAY
WM. POOL PARKER
H. A. STOCKLY, Sec'y of Comm.

SECRETARY TO THE SECRETARY

S. M. SNEDEKER

COMMITTEE ON PAPERS

LEWIS H. KENNEY, CHAIRMAN

SPECIAL MEETING

At Museum of University of Pennsylvania,
Friday, November 9, 1917, 8.15 P. M.

Dr. William Curtis Farabee, Curator, American Section, of the University of Pennsylvania Museum, will present an address on "**Explorations among the Wild Tribes of South America.**"

The address will be illustrated with lantern slides.

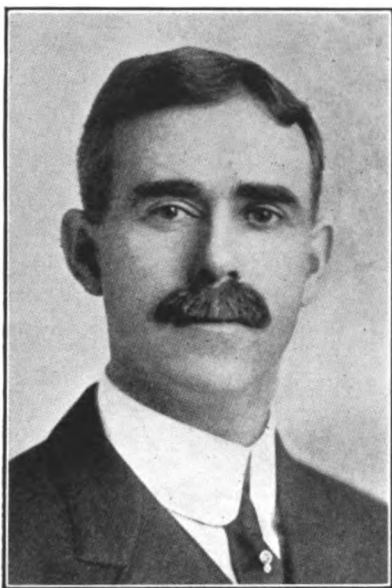
Members of Affiliated Societies are cordially invited to attend.

Members of the Club and Affiliated Societies are privileged to invite ladies.

Dr. Farabee has spent six years among the wild tribes of South America for Harvard University and the University of Pennsylvania.

A cordial invitation is extended by Dr. Farabee to the members to visit the Museum at the conclusion of the address to inspect the many unique trophies obtained by him while in South America.

The Committee on Papers considers that the members will have an opportunity of hearing an unusual and extremely interesting address.



MEETING FOR JUNIOR MEMBERS

November 13, 1917.—**Meeting at the Engineers' Club.** The following papers will be presented:

"Chemistry of Clays for Fire Brick and Fire Cements." By **Leonard Zoole.**

"Fire Brick and Cement in Oil Burning Boilers." By **M. M. Kennedy.**

Each Junior should give thoughtful consideration to the preparation of a paper for the Junior Prize.

REGULAR MEETING

**Joint Meeting of Engineers' Club and the Worcester Tech Club,
at Witherspoon Hall, Tuesday, November 20, 1917, 8.15 P. M.**

The paper of the evening, "**Engineering and Construction Features of Cantonments,**" will be presented by **Major Richard C. Marshall, Jr., Quartermaster Corps, U.S.A., Assistant to Officer in Charge of Cantonment Construction.**

A synopsis of Major Marshall's paper appears on page 517.

The paper will be illustrated with lantern slides and motion pictures.

Members of Affiliated Societies are cordially invited to attend.

Members of the Club and Affiliated Societies are privileged to invite ladies.



SYNOPSIS OF PAPER

"ENGINEERING AND CONSTRUCTION FEATURES OF CANTONMENTS"

To be presented by **Major Richard C. Marshall, Jr.**, Quartermaster Corps, U. S. A., at Joint Meeting of Engineers' Club of Philadelphia, and the Worcester Tech Club, November 20, 1917.

Introduction—

1. Past practice in camp construction.
2. Conception and reason for cantonment substitute for camp.
3. Reason for location and size of cantonments.
4. Relation to conscription.
5. Reasons for difference between cantonments for National Army and camps for National Guard.

Selection of Sites—

1. Acreage required including base hospital, remount station, rifle range, maneuver field, acreage conditions, etc.
 2. Availability of railroad, water supply, sewage disposal, topography, clearing of ground, roads, cost of land, etc.
- Method of selecting sites, by whom and under whose immediate direction.

Organization of Cantonment Division—

1. Personnel when state of war was declared.
2. Preliminary work done prior to that date.
3. Conception and rapid enlargement of organization.
4. Scheme of organization, Administrative, Engineering, Materials, Construction and Accounting with functions of each.
5. Constructing Quartermaster each Cantonment.

Design of Typical Cantonment—

1. Original personnel, animals and equipment.
2. Adoption of building units and necessary relationship of such units to each other under then existing army organization.
3. General arrangement of cantonments and reasons therefor.
4. Detailed design of company barracks and officers' quarters, together with interior equipment—ranges, refrigerators, cots, kitchen and mess, tables, seats, and shelves and heating arrangement.
5. Water supply, distribution and plumbing.
6. Sewage collection and disposal.
7. Railroad tracks, permanent and for construction.
8. Division warehouses, passenger station, etc.
9. Roads and walks.
10. Electricity supply and distribution.
11. Street lighting.
12. Heating and fuel handling facilities.
13. Garbage collection and disposal facilities.
14. Remount station and stables which form part of regimental units.
15. Division brigade and regimental headquarters.
16. Hospitals and regimental dispensaries, capacity arrangement, etc.
17. Y. M. C. A. and Knights of Columbus and similar buildings.
18. Theatres, officers' club, hostesses' building, etc., for division.
19. Examples of departure from typical because of extraordinary local conditions.

Mobilization and Transporting Materials—

1. Methods of locating principal material.
2. Pricing and mobilizing material.
3. Final requisition for material by contractor under instructions of Constructing Quartermaster of individual cantonment.

4. Expediting of manufacture and of shipment priority, etc.
5. Transportation and tracing of shipment.
6. Quantity and grade of lumber, mill work, etc.
7. Quantity and character of water pipe, wood stave, cast iron and wrought steel.
8. Quantity and character of sewer pipe.
9. Quantity and character of other plumbing materials.
10. A few interesting statistics, for example, the area that could be covered by the area of board feet of lumber used in the sixteen original cantonments and the total number of miles of water and sewer pipe if all laid end to end, area and character of roofing, and so on.

Construction Management—

1. Constructing Quartermaster's functions and typical organization at each cantonment.
2. Selection of Constructing Quartermaster, office staff, engineering and auditing staff.
3. Directions from, and daily telegraphic and other reports to, Cantonment Division, Washington, D. C.
4. Adaptation of typical engineering plans to local conditions by engineering staff.
5. Selection of contractor.
6. Form of contract and reasons for adoption.
7. Contractor's typical organization.
8. Ordering and checking material on receipt for quantity and for sequence necessary in construction.
9. Checking material for quality.
10. Distributing material on job.
11. Power saws and other labor savers in carpentry.
12. Soil pipe assembly.
13. Trenching machines.
14. Temporary water supply and sanitation.
15. Housing and feeding employees and commissary and amusement.
16. Securing of competent labor.
17. Rates of pay and overtime.
18. Time keeping and paying methods.
19. Coordination of parts of cantonment construction.
20. Development of attitude and interest in work.
21. Fire prevention and fighting provision.
22. Guarding property.

Finance and Accounting—

1. Appropriation and funds available.
2. Disbursements by Constructing Quartermaster.
3. Central Division and Field Auditors.
4. Checking invoices for materials.
5. Checking payrolls.

Completion and Use to Date of Cantonments—

1. Dates of arrival of officers.
2. Dates of arrival of 1st, 2nd, and 3rd increments and total personnel at each camp.
3. Extension on new army basis.

Acknowledgments—

1. To public press, to railroads, manufacturers, jobbers, public utilities, to individual communities, and to the public generally.

CALENDAR OF REGULAR MEETINGS

THE ENGINEERS' CLUB AND AFFILIATED SOCIETIES

1917-1918

DAY OF MONTH AND WEEK	NAME OF SOCIETY
First Monday	American Society of Civil Engineers January 7, April 1.
Second Monday	American Institute of Electrical Engineers November 12, December 10, January 14, February 11, March 11, April 8, May 13, June 10.
Second Tuesday	Engineers' Club (Junior Meeting) November 13, December 11, January 8, February 12, March 12, April 9.
Third Tuesday	Engineers' Club (except December, January and February) November 20, March 19, April 16, May 21, June 18.
Fourth Tuesday	American Society of Mechanical Engineers November 27, December 11, January 9, January 22, February 26, March 26, April 23, May 28, June 25.
First Wednesday	Technology Club November 7, December 5, January 2, February 4, March 6, April 3, May 1, June 5.
Third Wednesday	Engineers' Club (December and January) December 19, January 16.
First Thursday	Worcester Tech. Club November 1, December 6, January 3, February 7, March 7, April 4, May 2, June 6.
Second Thursday	American Society of Heating and Ventilating Engineers November 8, December 13, January 10, February 14, March 14, April 11, May 9, June 13.
Fourth Thursday	Society of Automotive Engineers November 22, January 24, February 28, March 28, April 25, May 23, June 27.
Third Friday	Engineers' Club (February) February 15.
Third Friday	Illuminating Engineering Society November 16, December 21, January 18, February 15, March 15, April 19, May 17, June 21.

Engineers' Club Meetings at Witherspoon Hall will be as follows:

Tuesday, November 20, Joint Meeting with **Worcester Tech. Club**.
 Wednesday, December 19, Joint Meeting with **American Institute of Electrical Engineers**.
 Wednesday, January 16, **Engineers' Club** Meeting.
 Friday, February 15, **Engineers' Club** Meeting.

Members of all Affiliated Societies are invited to these meetings.

SECRETARY'S NOTICES

A BUSINESS MEETING of the Club will be held on **Tuesday evening, November 20th, 1917**, at **Witherspoon Hall**.

The following list of names submitted by the Board at the Regular Meeting of the Club on October 16th, to constitute the Committee on Nominations for the current year, will be brought up for alteration or acceptance, in accordance with Article V, Section 3 of the By-Laws:

THOMAS C. MCBRIDE	W. P. DALLETT
CARL HERING	F. C. DUNLAP
W. P. TAYLOR	W. J. SERRILL
STAUNTON B. PECK	

H. A. STOCKLY, *Secretary*.

ABSTRACT OF MINUTES OF THE REGULAR MEETING OF THE CLUB

HELD TUESDAY EVENING, OCTOBER 16, 1917

The meeting was called to order by President Vogleson at 8.25 P.M., at Witherspoon Hall. About 800 members and guests were in attendance.

The minutes of the Regular Meeting of September 18, as printed in the JOURNAL, were approved.

ANNOUNCEMENTS

The Board of Directors elected, at its last meeting, the following to membership: Active, 18; Junior, 4.

In accordance with Article V, Section 3 of the By-Laws, the Board of Directors, at its Regular Meeting on October 9, elected a Committee on Nominations for the current year, the personnel of which is given in the above notice.

The By-Laws require that the Club shall accept or alter this list at the next Regular Meeting, November 20.

The paper of the evening, entitled "The War's Effect on Merchant Shipbuilding," was presented by Mr. Homer L. Ferguson, President of the Newport News Shipbuilding and Dry Dock Company.

A unanimous vote of thanks was extended to the speaker.

The meeting adjourned at 10.05 P.M.

ABSTRACT OF MINUTES OF SPECIAL MEETING OF THE BOARD OF DIRECTORS

SEPTEMBER 24, 1917

The meeting was called to order at 7.15 P.M., with President Vogleson, Vice-President Eglin, Directors—Fernald, Henderson, J. C. Wagner, Kenney, Moody, S. T. Wagner, Forstall, Bullens, Ehle, Robert M. Barr, and the Secretary in attendance. Director George W. Barr, Vice-President Andrews, and Past President Swaab were excused. Vice-President Yarnall, Director Hayward,

Past Presidents Ledoux and Carter, and the Treasurer were absent.

Mr. Wm. Pool Parker, member of the Building Committee, representing Mr. Swaab, and Mr. W. L. Plack, architect on the proposed improvements to the property, 1315 Spruce Street, were also present.

REPORT OF THE BUILDING COMMITTEE

Mr. Parker stated that the Building Committee met on September 13, with Mr. Plack, and approved the proposed plans in general, so far as they indicated the general scheme; *i.e.*, enlarged dining-room and kitchen, auditorium, and the general scheme of rearranging bedrooms to provide light facilities, bathrooms, etc.

From a financial standpoint, it was thought wise to divide the building program into units, this being necessitated by the limited amount of funds available.

Mr. Parker suggested that the Board approve the entire plan as outlined; use what money is immediately available to build the first unit, making it complete and serviceable, and, as more funds are available, build additional units.

The Committee considered that it was most desirable to complete the first-floor alterations as the first part of the program. This would include the installation of a new heater, entire new kitchen and dining-room, ready for service, new refrigerating plant to carry considerable stock, and the complete furnishing of the additional dining-rooms, so that the entire benefit of the service of these rooms would be derived. In addition, it is proposed to run a series of columns up from the foundations, for the proposed new auditorium, this work to be done while the main-floor alterations are in progress.

The next step, as funds become available, would be to proceed with the enlarged auditorium, bedrooms, etc.

Action: The Board accepted the report as outlined, and approved the plans and specifications as prepared by the architect, Mr. Plack, and approved by the Building Committee.

ENGINEERS' CLUB OF PHILADELPHIA

The question of whether to proceed with the auditorium first, or with the dining-room and kitchen arrangements first, was considered.

Action: The Board directed that the dining arrangements be taken up first and the auditorium second.

Mr. Plack stated that, under favorable conditions, it would require about ten or twelve weeks to complete the first-floor arrangements.

The Committee requested the Board's approval as to the method of letting contracts.

Action: The Committee was authorized to enter into contracts as follows:

For either new or special equipment on a lump sum basis, wherever possible or desirable; and for alteration work on a cost plus percentage basis, where it would not be practical to secure lump sum bids, due regard being paid in both cases to the individual items which go to make up the cost, or the cost and percentage part of the work.

Action: The thanks of the Board were extended to Mr. Plack and to the Building Committee for their commendable work in connection with the proposed alterations.

NEW BUSINESS

A letter from Mr. Jonathan Jones was presented, tendering his resignation as Treasurer of the Club, due to the fact that he has been called into the service of the Federal Government.

Action: Resignation accepted with regret, and the matter of filling the vacancy of Treasurer referred to the Executive Committee, with power to act.

Action: Mr. W. M. Irish was appointed Acting Treasurer of the Club.

Owing to pressure of duties, Mr. Wm. C. L. Eglin tendered his resignation as Chairman of the Committee on Finance, agreeing, however, to remain a member of the Committee.

Action: Mr. Eglin's resignation as Chairman of the Committee was accepted with deep regret, and with the thanks of the Board for the services which he has rendered.

Action: Mr. Walter E. Long was appointed Chairman of the Committee on Finance, and Mr. Eglin appointed to membership thereon.

The meeting adjourned at 8.55 P.M.

ABSTRACT OF MINUTES OF REGULAR MEETING OF THE BOARD OF DIRECTORS

OCTOBER 9, 1917

The meeting was called to order at 7.30 P.M., with President Vogleson, Vice-President Yarnall, Directors Fernald, Joseph C. Wagner, Kenney, Moody, Forstall, Bullens, George W. Barr, Past President Swaab and Secretary Stockly in attendance. Vice-Presidents Andrews and Eglin, Directors Henderson, Hayward, Samuel T. Wagner, Robert M. Barr, Past President Ledoux and Treasurer *pro tem.* Irish were excused. Director Ehle and Past President Carter were absent.

The minutes of the Regular Meeting of September 11 and the Special Meeting of September 24 were approved.

REPORT OF THE PRESIDENT

Mr. J. Franklin Stevens has been appointed the fifth member of the Committee on National Service.

At the request of Colonel Littell, of the Quartermaster's Department, Washington, D. C., the following have been appointed to constitute a Special Committee on Electrical Apparatus for Federal Service:

H. F. Sanville, Chairman	Paul Spencer
H. P. Liversidge	W. F. James

A letter has been received from Colonel Littell, extending thanks to Mr. Sanville, Chairman of the Special Committee, and also thanking the Committee and the Club for their services in connection with the listing of available electrical apparatus in this district.

The Junior members of the Club have perfected a team organization for the acquisition of new members. The Board granted a request to present a Club emblem (in recognition of their service to the Club) to each of the members of the team obtaining the greatest number of new members.

After discussion it was decided that the chairmen of committees not members of the Board be invited to attend meetings of the Board.

The Executive Committee, under authority granted by the Board, September 24, elected Mr. J. Franklin Stevens Treasurer, *vice* Mr. Jonathan Jones, resigned, and Mr. W. M. Irish, Acting Treasurer.

REPORT OF THE SECRETARY

Under Article V, Section 3 of the By-Laws, requiring the submission to the Club at the regular meeting in October of the names of seven Active members in good standing and not officers of the Club, to constitute a Committee on Nominations for the current year. The Committee was appointed by the Board, the Committee to elect its chairman at its organization meeting.

Resignations from the following members in good standing were received and accepted as of March 31, 1918:

C. W. Brown	William L. Wall
S. S. Walker	R. P. Farrington

The resignation of Dr. Edgar Marburg, as a member of the Committee on Public Relations, was received, accepted with regret, and the President authorized to appoint the vacancy.

The estimated annual income from the restaurant was about \$1000.00 low, and the estimated expenses were each about \$1000.00 low. Present indications are that both deficits can be taken care of from other appropriations.

Final arrangements for the purchase of No. 1315 Spruce Street have been carried out, and settlement made for \$15,508.57. First payment on the property amounted to \$15,000.00, with a \$20,000.00 mortgage:

SECRETARY'S NOTICES

taxes for the remaining months in the year, \$189.57; perpetual fire insurance, \$184.00, purchased outright from the Girard Trust Company; for insurance of title and for acknowledgment of deed and notary's fee, \$135.00.

REPORT OF THE TREASURER

The financial report submitted to the members previous to the meeting, in accordance with the action of the Board at the September 11 meeting was accepted.

REPORT OF THE COMMITTEE ON HOUSE

Chairman Gant presented a report which was accepted.

REPORT OF THE COMMITTEE ON MEMBERSHIP

Chairman Yarnall presented a report, and the following were elected:

To *Active* Membership:

Walter G. Armstrong	Roger M. Netherland
Harry Paul Barnes	Henry L. Price
Maury Polk Gregg	Walter R. Richards
Edward B. Harold	Hugh Schlatter
Richard Howell	Sigfrid E. R. Siven
Walter M. Joyce	Frank Sutcliffe
Clarence A. Long	Herbert Talley
Frank H. McGraw	Lewis B. Van Leuren
Charles A. Meade	Frank Webster

To *Junior* Membership:

Gordon W. Anderson	David E. Waite
Robert W. Hendee	William R. Watt

REPORT OF THE COMMITTEE ON PUBLICATION

Chairman Wagner reported that several inquiries having been received from publishers and dealers as to the commission the Committee on Publication would grant for obtaining subscriptions to the JOURNAL, the Committee, at its regular meeting, September 28, unanimously recommended that a commission in an amount of 33½ per cent. be allowed for each subscription received from dealers, and the Board approved the recommendation.

The September Proceedings cost \$725.00, the income from advertising was \$572.00, leaving a deficit of \$123.00, which is within \$100.00 of the monthly budget appropriation.

REPORT OF THE COMMITTEE ON PAPERS

Chairman Kenney reported that the Committee had engaged Witherspoon Hall for the Club Meetings on December 19, 1917, January 16, and February 15, 1918, and the Board approved.

The Committee is arranging for several technical papers to be presented at the Club-house, and for special meetings elsewhere, and the Board approved.

REPORT OF THE COMMITTEE ON MEETINGS

Chairman *pro tem.* Kenney reported that at a recent meeting of the Committee the schedule of papers for the

A. I. E. E., A. S. M. E., and the Engineers' Club was submitted, and that preliminary arrangements were made for additional joint meetings.

The representatives of nearly all the affiliated societies stated that their papers would be available for publication in the JOURNAL.

REPORTS OF SPECIAL COMMITTEES

The special Committees on Public Relations, By-Laws, Increase of Affiliated Societies, and National Service presented no reports.

BUILDING COMMITTEE

Chairman Swaab, reporting for the Committee, stated that, as the conversion of the present and recently acquired properties into a commodious Club-house requires a considerable amount of work of such a character as could not ordinarily be placed under contract for a given amount on the basis of competitive bidding, the rule adopted by the Building Committee was that contracts of the type generally designated as time and material contracts should be made only for work of the nature of alterations to either or both buildings, but for all work of such size as to be attractive to builders, for which adequate plans could be made in advance and which were not likely to become involved as the work progressed by conditions arising out of the uncertain character of the work, it was taken to be the part of wisdom to let by ordinary contract on a lump sum basis.

The auditorium, while necessary, and, in fact, quite desirable at this time, was not considered by your Committee to be of paramount importance, but improved and enlarged kitchen facilities and dining-room and cold storage, including refrigerating plant, adequate heating equipment for the entire building, increased coal storage, together with new kitchen and dining-room apparatus and equipment, comprised the items of the work the procuring of which, if we are to remain afloat as a Club, providing housing facilities for our membership, must be secured forthwith.

The auditorium facilities can be had outside the Club-house if that is deemed necessary, but the latter facilities must, of necessity, be provided within the premises.

It is desirable, in carrying on the alterations, to interfere with the continued use of the Club-house by our members as little as possible. Fortunately the above program lends itself to this purpose admirably.

The new cold storage, kitchen, and dining-room can be built ready for occupancy without seriously interfering with the use of the present facilities. Also the addition to the lobby and parlor can be made and supporting columns set for the auditorium girder with a minimum of inconvenience. After this first-floor program is completed, all work above the first floor, such as auditorium and bedroom alterations, can be carried out without disturbing anything on the first floor.

It might be mentioned, in passing, that special care has

(Continued on Page 538)

COMMITTEE ON MEMBERSHIP

D. ROBERT YARNALL, CHAIRMAN

CANDIDATES FOR MEMBERSHIP

Members having knowledge of the candidates are invited to submit to the Committee on Membership before November 12 a confidential expression of opinion as to the eligibility of the candidates; all communications to be addressed, "Chairman of the Committee on Membership, Engineers' Club, Philadelphia," marked "Confidential."

All applications are on file at the Club and can be referred to by any member.

FOR ELECTION TO ACTIVE MEMBERSHIP

CARROLL BEALE

Hotel Stenton, Philadelphia, Pa.
Civil Engineer, Chester Shipbuilding Company.
Proposed by G. E. Dale and E. E. Seyfert.

THEODORE THOMAS BURCHFIELD

604 Arch Street, Philadelphia, Pa.
Engine, Boiler & Machinery Business, T. T. Burchfield Co.
Proposed by George F. Pawling, James L. Lawley, W. P. Dallett.

WARREN F. BUZBY

Care of Keystone Lubricating Company, Philadelphia, Pa.
Sales Engineer, Keystone Lubricating Company.
Proposed by Thomas Reed and Russell E. Shaw.

RONALD G. COOLBAUGH

Care of Camden Forge Company, Camden, N. J.
Buyer, Camden Forge Company.
Proposed by W. J. Bailey and M. M. Price.

HARRY ALBERT KAUPP

Central Y. M. C. A., Philadelphia, Pa.
Treasurer and Manager, The Norbom Engineering Company.
Proposed by George F. Pawling and James L. Fawley.

JOHN C. MILLER

910-4 Huntingdon Street, Philadelphia, Pa.
Mechanical Engineer, Keystone Lubricating Company.
Proposed by Thomas Reed and Russell E. Shaw.

RICHARD I. MOTYSEK

1610 Wallace Street, Philadelphia, Pa.
Draftsman, Atlantic Refining Company.
Proposed by Charles B. Buerger, Lester M. Goldsmith, and Carl F. P. Carrier.

VICTOR L. SANDERSON

605 Widener Building, Philadelphia, Pa.
District Sales Manager, Terry Steam Turbine Company.
Proposed by H. P. Grant and A. T. Lewis.

FOR ELECTION TO JUNIOR MEMBERSHIP

FRANK FORREST BOETTCHER

2847 Germantown Avenue, Philadelphia, Pa.
Assistant Combustion Engineer, United Gas Improvement Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

RALPH WHERRY BYE

1920 Carey Street, Philadelphia, Pa.
Assistant Foreman, Midvale Steel and Ordnance Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

HENRY WALTER SCOTT DEEMER

6708 North Seventh Street, Oak Lane, Philadelphia, Pa.
Mechanical Estimator.
Proposed by John P. Mudd and Emmett B. Carter.

QUINTIN TODD DICKINSON

561 North Sixty-third Street, Philadelphia, Pa.
Chemical Engineer, The Barrett Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

JAMES M. DOYLE

906 South Broad Street, Philadelphia, Pa.
Computer, Valuation Department, Philadelphia and Reading Railroad Company.
Proposed by Harry N. Payne and William J. Doyle, Jr.

HAROLD M. FOSTER

2207 West Street, Wilmington, Del.
Metallurgical Engineer, Midvale Steel Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

ALEXANDER FRANK

3227 West Berks Street, Philadelphia, Pa.
Checker in Mechanical Engineering Department, Philadelphia Electric Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

DAVID MURRAY GILTINAN

213 East Upsal Street, Germantown, Philadelphia, Pa.
Assistant Engineer, Bureau of Research, Midvale Steel Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

MAURICE GOLOVE

2412 North Thirty-first Street, Philadelphia, Pa.
Engineering Inspector, Bureau of Highways.
Proposed by Fred C. Dunlap, W. P. Taylor, and Charles F. Puff, Jr.

SOL PAUL HERMAN

334 Kimball Street, Philadelphia, Pa.
Senior at University of Pennsylvania, in Civil Engineering.
Proposed by W. M. Boehm and Lewis H. Kenney.

JOHN M. HOLMES

1859 North Thirteenth Street, Philadelphia, Pa.
Assistant to Superintendent, Jacob Myers Sons Company.
Proposed by Wm. F. Schmid and Frank A. Myers.

RICHARD PIERCE HORNER

1005 South Fifty-first Street, Philadelphia, Pa.
Draftsman, Atlantic Refining Company.
Proposed by Charles B. Buerger, Lester M. Goldsmith, and C. J. Cutting.

COMMITTEE ON MEMBERSHIP

REUBEN KOHEN

1408 South Thirteenth Street, Philadelphia, Pa.
Civil Engineering Student, University of Pennsylvania.
Proposed by W. M. Boehm and Lewis H. Kenney.

JAMES ERLE McCAMBRIDGE

4638 North Mervine Street, Philadelphia, Pa.
Chemical Engineer, American Manganese Bronze Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

DEACON TAYLOR McCaULLEY

5320 Wayne Avenue, Philadelphia, Pa.
Production Clerk, Midvale Steel Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

JEROME S. MARCUS

3725 North Eighteenth Street, Philadelphia, Pa.
Draftsman.
Proposed by Lewis H. Kenney, Jonathan Jones and Walter M. Boehm.

ALLISON C. MILLS

4613 Newhall Street, Philadelphia, Pa.
Chemical Engineer, Midvale Steel Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

LOUIS AARON JONAH RABINOWITZ

3950 Girard Avenue, Philadelphia, Pa.
Civil Engineer.
Proposed by W. M. Boehm and Lewis H. Kenney.

WILLIAM FREDERICK ROMMEL

604 Benson Street, Camden, N. J.
Production Supervisor, Forging Department, Midvale Steel Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

SAMUEL LEON SCHWARTZ

Care of Department of City Transit, Room 748, Bourse Building, Philadelphia, Pa.
Draftsman, Department of City Transit, Philadelphia, Pa.
Proposed by Alfred A. Townsend and Lawrence B. Manley.

STANLEY WILLIAM SMITH

338 North Sixty-second Street, Philadelphia, Pa.
Draftsman, City of Philadelphia.
Proposed by Herbert M. Packer, W. M. Boehm and Lewis H. Kenney.

BENJAMIN SOFFE

237 Federal Street, Philadelphia, Pa.
Filtration Engineer, with Hungerford & Terry, Inc.
Proposed by W. M. Boehm and Lewis H. Kenney.

EDGAR K. SPRING

2049 Ontario Street, Philadelphia, Pa.
Metallurgical Engineer, Midvale Steel Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

BENJAMIN STAMBLER

1135 Wingohocking Street, Philadelphia, Pa.
Manufacturing Chemist.
Proposed by W. M. Boehm and Lewis H. Kenney.

GEORGE BRUCE STAPLES

4613 Newhall Street, Germantown, Philadelphia, Pa.
Mechanical Engineer, Midvale Steel Company.
Proposed by Walter M. Boehm and Lewis H. Kenney.

JOHN A. STINSON

121 North Sixtieth Street, Philadelphia, Pa.
Production Engineer, Midvale Steel Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

JACOB WILLIAM STIRZEL

1517 Erie Avenue, Philadelphia, Pa.
Engineer, United Gas Improvement Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

LEWIS JOHN DANIEL TRUHALL

1610 West Columbia Avenue, Philadelphia, Pa.
Mechanical Engineer, C. H. Wheeler Manufacturing Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

JACOB A. WILSON

3231 North Sydenham Street, Philadelphia, Pa.
Computer, Department of Valuation, Philadelphia and Reading Railroad Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

HARRY WOLF

1401 West Second Street, Chester, Pa.
Structural Draftsman, International Shipbuilding Corporation.
Proposed by W. H. Boehm and Lewis H. Kenney.

LEWIS A. YOUNG

5309 Angora Terrace, Apartment B, Philadelphia, Pa.
Division Engineer, Portland Cement Association.
Proposed by W. M. Boehm and Lewis H. Kenney.

POSITIONS OPEN

Young man wanted, with knowledge of wiring, for incandescent lighting, and sufficient experience to pick up low-pressure, direct steam-heating work. Apply Engineers' Club, No. 160-A.

Mechanical draftsman, experienced in working up designs of detail parts, and some experience in general design. Good opportunity with recently incorporated firm in Philadelphia. Applicant state age, experience, reference, and salary desired. Apply Engineers' Club, No. 169-A.

Draftsman Wanted.—Designers, detailers, and tracers. Apply Engineers' Club, No. 172-A.

DESK ROOM WANTED

Wanted; Desk room in office between Market and Spruce Streets; east of Fifteenth Street, with use of telephone, and with or without use of stenographer. Apply 3-c, Engineers' Club.

Graduate engineer wanted for work on plans and erection of motor-driven pumping station in western Pennsylvania. Reply by letter, stating age, education, experience, and salary desired. Apply Engineers' Club, No. 173-A.

Construction Engineer wanted on general construction, cost-keeping, etc., assistant to resident engineer in charge of blast furnace and heavy concrete construction. Apply Engineers' Club, No. 174-A.

Technical graduate—electrical, 18 to 30 years of age, with experience in telephone and telegraph work, not necessarily an operator. Apply Engineers' Club, No. 175-A.

POSITION WANTED

Structural Engineer, technical graduate with 8 years' broad experience in design, detail, estimate and erection of structures of every description in wood, steel and concrete and responsible charge of such work, desires position. Apply Engineers' Club No. 171.

COMMITTEE ON NATIONAL SERVICE

GUILLIAEM AERTSEN, CHAIRMAN

MEMBERS OF ENGINEERS' CLUB WHO HAVE BEEN CALLED INTO SERVICE IN THE ARMY OR NAVY OF THE UNITED STATES AS OF OCTOBER, 22, 1917

NAME	RANK	CORPS	LOCATION
ALDRICH, J. T.	1st Lieutenant	Ordnance Officers' Reserve Corps	Washington, D. C.
ALLEN, J. G.		Co. 12 Infantry, Reserve Officers' Training Camp	Port Oglethorpe, Chattanooga, Tenn.
ANDERS, D. W.	Captain	Company D, 502nd Engineers	Overseas Service
ANDREWS, J. H. M.	Major	103rd Engineers	Camp Hancock, Augusta, Ga.
ASPLUNDTH, E. T.	Captain	103rd Engineers	Camp Hancock, Augusta, Ga.
ATTERBURY, W. W.	Brigadier-General	Director-General of Railways	France
BELL, FRANK F.	1st Lieutenant	Signal Corps, Aviation Station	Essington, Pa.
BOOZ, H. C.	Major	In Charge of Construction of Railroads, Wharves, etc.	France
BOYD, G.	1st Sergeant	Overseas' Repair Section No. 1	Gas Defense Service, Medical Corps
BRADFORD, J. S.	Captain	103rd Engineers	Camp Hancock, Augusta, Ga.
BREAM, C. C.	Corporal	103rd Engineers	Camp Hancock, Augusta, Ga.
BREEN, J. W.	Captain	Engineer Officers' Reserve	
BROADHEAD, ALEX.		19th Reserve Engineers	American Expeditionary Forces, France
BROWN, P. D.		Reserve Engineers	France
BROWN, R. V.	Lieutenant	Q. M. C., 304 Divisional Trains	Camp Meade, Admiral, Md.
BRYANT, C. M.		Naval Coast Defense	Philadelphia Navy Yard
BUTLER, E. N.	2nd Lieutenant	103rd Engineers	Camp Hancock, Augusta, Ga.
CACCAVAJO, JOS.	Captain	Engineers' Training Camp	Washington, D. C.
CARNEY, R. E.	{ Asst. Engr. U. S. N. (Retired) }	Pearl Harbor Naval Station	Hawaii
CHILDS, H. P.		7th Infantry, Reserve Officers' Training Camp	Ft. Myer, Va.
COLGAN, R. J.	Captain	American Expeditionary Forces	Care of Adjutant-Gen'l, Washington, D. C.
CRAMPTON, G. S.	Major	Director of Field Hospitals, 28th Div.	Camp Hancock, Augusta, Ga.
CUMINGS, C. A.	Captain	Quartermaster Officers' Reserve	Ft. Sam Houston, Texas
CUTLER, JAMES B.		Reserve Officers' Training Camp	Fort Oglethorpe, Chattanooga, Tenn.
DILL, C. M.		Company K, 319th Infantry	Camp Lee, Petersburg, Va.
DONNELLY, J. B.	1st Lieutenant	103rd Engineers	Camp Hancock, Augusta, Ga.
DOYLE, T. H.	2nd Lieutenant	Quartermaster Officers' Reserve	Camp Meade, Md.
DUNN, M. L.	Ensign	Reserve Officers' Quarters	U. S. Naval Academy, Annapolis, Md.
DYSON, C. W.	Captain	Bureau of Steam Engineering, U. S. N.	Washington, D. C.
ELCOCK, CHAS.	1st Lieutenant	103rd Engineers	Camp Hancock, Augusta, Ga.
FULWEILER, J. E.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
GAILING, H. W., JR.	Private	Marine Corps (Aviation)	Philadelphia Navy Yard
GARFORTH, EZRA		Engineers' Training Camp	American University, Washington, D. C.
GAUM, CARL G.	1st Lieutenant	Engineers' Training Camp	Washington, D. C.
GAUTHIER, JORDAN	2nd Lieutenant	Engineers' Training Camp	American University, Washington, D. C.
GEST, J. B., 2ND	2nd Lieutenant	Engineer Officers' Reserve Corps	American University, Washington, D. C.
GETZ, RALPH F.		19th Reserve Engineers	American Expeditionary Forces, France
GRAVELL, W. H.		Engineers' Training Camp	American University, Washington, D. C.
GRIFFIN, R. S.	Rear Admiral	Eng. in Chief, U. S. N. Bur. of Steam Engineering	Washington, D. C.
GWILLIAM, MARK R. M.	1st Lieutenant	21st U. S. Infantry	San Diego, California
HALL, W. A.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
HARDING, R. L.		Engineers' Training Camp	American University, Washington, D. C.
HARROWER, R. A.		American Red Cross Ambulance Corps	France
HATHAWAY, H. K.	Captain	Ordnance Officers' Reserve Corps	Washington, D. C.
HAYDOCK, ROGER		Engineers' Training Camp	American University, Washington, D. C.

COMMITTEE ON NATIONAL SERVICE

HETHERINGTON, S. C.	Lieutenant	315th Infantry	Camp Meade, Admiral, Md.
HOLLENBACK, E. E.	Major	109th Infantry	Camp Hancock, Augusta, Ga.
HULME, NORMAN	Lieutenant	Co. 4, Engineer Officers' Training Camp	Fort Leavenworth, Kansas
JONES, JONATHAN	Captain	Engineer Officers' Reserve Corps	American University, Washington, D. C.
KERN, F. X.		Engineers' Training Camp	American University, Washington, D. C.
KNEASS, E.	Ensign	U. S. Naval Academy	Annapolis, Md.
KNOWLES, MORRIS		4th National Army Division Cantonment	Admiral, Md.
LAWRENCE, G. E.	Lieutenant J.G.	Naval Coast Defense	Philadelphia Navy Yard
LAWSON, T. W.	1st Lieutenant	109th Infantry	Camp Hancock, Augusta, Ga.
LEVIN, J.		2nd Officers' Training Camp	Fortress Monroe, Va.
MAGEE, J. W.	2nd Lieutenant	Engineers' Training Camp	American University, Washington, D. C.
MALTBY, F. B.	Major	Engineer Officers' Reserve Corps	Army Building, N. Y.
MCCLINTOCK, J. L.	Private		Camp Meade, Admiral, Md.
MCCORD, J. B.	Captain	Ordnance Officers' Reserve	War Department, Washington, D. C.
MCCOY, J. F.		Aviation Section, Signal Corps	
MCGARRIGLE, J. J.		2nd Officers' Training Camp	Fortress Monroe, Va.
McMILLAN, H. L.	Captain	Engineer Officers' Reserve Corps	American University, Washington, D. C.
MILLAR, E. A., JR.	1st Lieutenant	Ordnance Officers' Reserve	Camp Hancock, Augusta, Ga.
MOODY, WM. M.		Reserve Officers' Training Camp	Fort Oglethorpe, Chattanooga, Tenn.
MYERS, W. T.	2nd Lieutenant	16th U. S. Cavalry	Mercedes, Texas
NEWLIN, E. M.	Captain	312 Machine Gun Battalion	Camp Meade, Admiral, Md.
NIXON-MILLER, M.	Captain	Company "B," 501st Engineers	Camp Merritt, N. J.
OAKES, J. C.	Colonel	113th Engineers	Camp Shelby, Hattiesburg, Miss.
OTWELL, CURTIS W.	Colonel	104th Engineers	Camp McClellan, Anniston, Ala.
PERRY, EDWARD		Quartermaster Officers' Reserve	Camp Lee, Petersburg, Va.
PETERMAN, J. M.	Private		Camp Meade, Admiral, Md.
PFEFFER, H. W.	1st Lieutenant	Ordnance Officers' Reserve Corps	Bethlehem, Pa.
PRICHETT, F. B.		First Troop, Phila. City Cavalry	Camp Hancock, Augusta, Ga.
PUGH, M. R.	Major	21st Engineers	Camp Grant, Rockford, Illinois
REED, R. W.	Private	19th Reserve Engineers	American Expeditionary Forces, France
REED, THOMAS	Captain	Ordnance Officers' Reserve Corps	Rock Island, Illinois
RENINGER, H. A.	{ Major & Adjutant, A.G. Dept. }	53rd Depot Brigade	Camp Hancock, Augusta, Ga.
RIDGE, R. S.	Sergeant	23rd Engineers	Camp Meade, Admiral, Md.
RIDGWAY, J. J.	1st Lieutenant		Camp Lee, Petersburg, Va.
RITCHIE, J. M.	Captain	Quartermaster Officers' Reserve	Washington, D. C.
ROGERS, C. B.		Electrical Research Dept., Aviation Section, Signal Corps	Mineola, L. I.
SANVILLE, L. F.	Private	108th Field Artillery, Penna. Troops	Camp Hancock, Augusta, Ga.
SCHWEGLER, O. F.		Reserve Officers' Training Camp	Fortress Monroe, Va.
SHUSTER, W. H., JR.	Lieutenant	314th Infantry	Camp Meade, Md.
SMITH, W. S.	Captain	Navy Department	Special Duty, Naval Consulting Board, Washington, D. C.
SPACKMAN, H. S.	Major	Engineer Officers' Reserve	Overseas Service
SPENCER, ALEX. G.		Royal Flying Corps	Toronto, Canada
TAWRESEY, J. G.	Naval Constructor	Navy Department	Construction Officer, Philadelphia Navy Yard
THACHER, C. F., JR.	1st Lieutenant	Engineer Officers' Training Camp	Belvoir, Va.
THACHER, C. H.	2nd Lieutenant	Engineer Officers' Training Camp	Belvoir, Va.
THOMAS, R. S.	Captain	Engineer Depot	Eagle Pass, Texas
THOMSOM, H. A.		Quartermaster Officers' Reserve	Camp Hancock, Augusta, Ga.
TILLSON, P. E.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
WARFEL, A. C.	2nd Lieutenant	Engineer Officers' Reserve Corps	
WARFEL, J. P.	Senior Lieut.	U. S. Naval Reserve Force	Philadelphia Navy Yard
WATSON, G. L.	Captain	Engineer Officers' Reserve Corps	
WHITE, W. M.	1st Lieutenant	103rd Engineers	Camp Hancock, Augusta, Ga.
WILD, H. J.	Captain	Engineer Officers' Reserve Corps	War Department, Washington, D. C.
WORK, LEONARD	1st Lieutenant	Signal Corps Aviation Section	Overseas Service
WORTH, J. G.	Captain	Quartermaster Officers' Reserve	Camp Wheeler, Macon, Ga.
ZINN, GEORGE A.	Colonel	District Engineers' Office, Custom House	Portland, Oregon

EXPERIENCED HIGHWAY CONSTRUCTION MEN FOR SERVICE IN FRANCE*

[This statement is authorized by Colonel Johnston, commanding the 23d Engineers.]

MEN who have had experience in any branch of road construction are offered an opportunity to see early service in France in special road-building battalions of the United States Army by recruiting plans here announced. These battalions will be required to repair and maintain the highways near the fighting front, over which tremendous traffic is operated continuously. They will also build new strategic highways in the war zone. Consequently, these troops, all volunteers, will be in the thick of the greatest activities.

The new battalions are constituted as regular military units and as a part of the regular army organization. They are fully armed and will be required in emergencies to fight along with other troops. Generally, however, they will be occupied with road work.

The battalions will form a part of the 23d Regiment of Engineers of the new National Army. This regiment will eventually have a strength of about 10,500 men—more than an ordinary brigade—and will, so far as is at present known, be the largest in the army. It will be commanded by Col. E. N. Johnston, of the Corps of Engineers, U. S. A.

MANY WORTH-WHILE JOBS

There will be more highly paid and high-ranking non-commissioned officers in the regiment, it is believed, than in any other. There will, therefore, be more openings for men of education and practical experience than is usually the case.

The organization of the battalions is as nearly the same as that of large contracting forces as is feasible. Modern road-building machinery has been fully provided, including rock-crushing plants, steam shovels, road rollers, tractors, graders, motor trucks and pumps. A full line of dump wagons, wheel and drag scrapers and similar dirt-moving equipment also will be available. Shops for the repair and maintenance of all the plants and equipment will be operated close to the front.

Much of the plant used on road work in America is new to European engineers, while the methods also are quite different from those used abroad. A great opportunity is thus offered to demonstrate what skill Americans can do with modern equipment, and the regiment which is now being recruited must include men to operate the necessary construction plant, to man the shops and, as non-commissioned officers, to handle the forces.

WHO CAN QUALIFY?

For the non-commissioned officer positions men are required who can qualify in private life in the following lines: Superintendents and assistant superintendents of highway, bridge and quarry works, of mechanical plant and transportation; chief clerks, material men, stock men, timekeepers; foremen for concrete, road, bridge and quarry work; powder men, riggers, carpenters, iron workers, surveyors and draftsmen.

For the enlisted personnel it is desired to secure men skilled and experienced in one or more of the following occupations: Surveyors, draftsmen, clerks, stenographers, axmen, blacksmiths, blacksmiths' helpers, machinists, gas-engine operators and repairers, crusher operators, hand drillers, drill runner (air drills), quarrymen, powdermen, masons, teamsters, pile driver operators, concrete, form, road and bridge men; tractor operators (gasoline), grader operators (blading and elevating graders), bridge carpenters, motor-truck drivers, chauffeurs, cooks, motor-truck and automobile repair men, pipe fitters, electricians, horseshoers, tailors, shoemakers, musicians (bugle, fife or drum), mechanics, telephone operators, steamfitters, tool sharpeners, ditchers, boatmen (builders and caulkers), shovel runners (gasoline), barbers, veterinarians, French interpreters, bituminous road men, iron workers, riggers, general utility men capable of driving automobiles, motor trucks and all types of gasoline-driven machinery.

Any male American citizen between 18 and 40 years of age, and who has not actually been called by a local board in the draft, is eligible for enlistment in these special battalions, if acceptable physically. All men must first enlist as privates, the rate of pay being \$33 per month and expenses. Men with the necessary experience may be assigned to special duties and given non-commissioned rank at rates of pay ranging from \$40.20 to \$96.00 per month and expenses. The latter include, for both privates and non-commissioned officers, food, clothing, medical attendance and transportation. Those who enlist will be eligible immediately for promotion, according to their ability and as openings occur. Men who are specially well qualified and recommended will be given definite promise of advancement to higher grades when their enlistment is authorized.

OFFICERS ARE SPECIALISTS

Colonel Johnston, who will command the regiment, was graduated from the United States Military Academy

(Continued on Page 538)

* Courtesy of *Engineering News Record*.



ILLUMINATING ENGINEERING SOCIETY

PHILADELPHIA SECTION

WALTON FORSTALL, Chairman

UNIT RASIN, Secretary, 1411 Widener Bldg.



ADDRESS*

By **WILLIAM J. SERRILL**
RETIRING PRESIDENT

AS it is not to be my great privilege to read this address in person to the members of the Society in convention assembled, and as this is the last occasion on which I may address them "from the chair," it seems to be not inappropriate that I should, as I now gladly do, express my appreciation of the loyal assistance and coöperation which I have received in the work of the year from the members of the Council, from the officers of the Society and of the Sections, from the Society's employees, and from the chairmen and members of the numerous committees. So ungrudging and so efficient has been this aid, that it has been to me a real pleasure to guide the Society's activities for a period that seems so brief that I cannot refrain from giving voice to my regret that it has come to an end.

This is not the place to recite the achievements or describe the activities of the year, but I think those who may read the report of the Council will realize that progress has been made and that the Society is in a state of sound health. The great war—the occasion of the omission of the Annual Convention of 1917—calls for the conservation of the Society's resources, and the administration of its affairs along conservative lines. It is a privilege to record that, by means of special committees, the Society is finding opportunities to do its share in rendering aid to the Government in the national emergency.

This address will first treat briefly some considerations of the general character and position of the Society. The experiences of the year have demonstrated the pertinence and need of this treatment. The remainder of the address will deal with the subject of gas lighting. I hope to be able to handle it in a manner which shall be helpful to those whose business it is to guide and extend it, and which shall be stimulative to the general cause of illumination.

The Illuminating Engineering Society is, in a certain sense, in a state of unstable equilibrium. Its stability depends upon a balance between widely diversified spheres of thought and endeavor. It has been well said that the Society stands on a tripod, being based on the three legs of the scientific, the commercial and the philanthropic. Its welfare depends upon the coöperation of these three principles. Now, nothing is steadier, or more stable than a three-legged stool. But its stability depends upon the maintenance of the three legs; each must bear its share

of the weight, and must continue to be able to bear it. If one of the legs bends through weakness, the stability of the structure is threatened.

It becomes therefore an important duty of each succeeding administration to maintain the balance between these principles, to nourish the one which may show signs of weakness, to defend the one which may be attacked. That the welfare of the Society is dependent upon the maintenance of such an equilibrium is a fact that is not apparent to the superficial, not understood of the thoughtless. Attacks against it come from all angles and from unexpected quarters. The commercially minded see only the commercial side of the Society's activities, and argue that there is no justification for its existence separate from the various commercial organizations in the lighting field; or the scientifically minded advance the thought that the research phase of illuminating engineering has been traversed, and that the Society's activities in the future must be devoted to the field of practical application and stimulation of the art; again it is urged that those whose lives are devoted to research have become *de trop* among the membership, and that it is better for them to transfer their activities and allegiance to strictly scientific societies; or it is alleged that the Society's popular propaganda detracts from, or interferes with, its work of promoting illuminating engineering. Some, their vision filled with their own field of work, cannot see that the Society covers also other fields; others, equally preoccupied, because they see her activities in other fields, fatuously assume that she is becoming inactive in their own.

Especially among the representatives of electric central stations and gas companies there is frequently occurring the thought that there are too many societies in the field, and that ours has no justification for an existence separate from the existing electrical, or gas, societies. These employees of the public utilities apparently make the assumption that our Society is only another electrical, or gas, association, and consequently, they maintain that, in the interest of simplicity, it might better be merged into the societies which represent these industries. Back of this assumption there is evidently, in many cases, another—equally false with the first one—namely, that the activities of the Society are mainly conducted by employees of the utilities.

Now, we know that the science and art of illumination are products of many diverse activities, that they are not

* Address delivered at meeting of Philadelphia Section of the Illuminating Engineering Society, September 21, 1917, at the Engineers' Club.

simple in their composition, that, if we would promote and develop them, we must solicit the aid of many art and sciences, and secure the coöperation of many professions. We realize the difficulty of obtaining and of permanently retaining, the allegiance of all of them, but we believe the object to be worth while, and we are not deterred by the difficulty. To tread a *via media* is not easy; not to drop any of the threads that are being woven into an elaborate pattern requires judgment and skill. Our Society demands these qualities in its management.

We believe the science and art of illumination to be worth cultivating, and that this can be done adequately only by a composite society like our own. The Society's position and reputation to-day demonstrate the feasibility of blending the many diverse elements into a harmonious whole, and the possibility of accomplishing useful achievements. As a foil to her instability stands her catholicity; offsetting her complexity and diffuseness stand her philanthropy, and her nobility of purpose in spreading the propaganda of the conservation of vision.

It would be superfluous for me to list for you the Society's current activities, or to catalog her achievements, in demonstration of the many-sided character of her subject—illumination. You are already familiar with them. I will, however, cite the work of one of the standing committees, which serves as an impressive example of this composite character. I refer to the Committee on Nomenclature and Standards. This committee, by its able, constructive work, has laid the foundation on which illuminating engineering is built. What a variety of names and subjects comes before it to define! And what eloquent testimony to the vitality and growth of the science is borne by the continual pressure for new names and more definitions! A review of the work of this committee, from its inception, will convince the most skeptical, that not any one of the allied commercial, engineering, or scientific societies, nor all of them combined, could or would have been able to lay so broad and substantial a foundation for this engineering science. Each of them might have contributed, from its own field and point of view, solid blocks to be built into the foundation, but nothing short of a body with an eye single to *illumination*, working in the interest of a Society which specializes on this one subject, could have joined these blocks so skilfully, and have constructed so broad and adequate a base, as we now possess. The achievements of this committee alone justify the existence of the Society, and furnish an answer to those who doubt.

The Society's success in some of its most important lines of endeavor is due to its disinterestedness, to the fact that it has no axe to grind. The adoption of its lighting codes by the governmental departments of the several states is a fact of first-rate significance. No commercial association formed to further the business interests of its members can hope to achieve results of this character. It would be difficult to conceive of such a commercial organization initiating, organizing and carrying to successful completion, the two great lecture courses at the

Johns Hopkins University and the University of Pennsylvania, or of its obtaining the acquiescence and support of these institutions in such enterprises.

So much in justification of the Society. The remainder of this address shall be devoted to a brief consideration of the status and prospect of gas lighting. The cause of artificial illumination would suffer if this illuminant should greatly decline. Competition is a healthy state. In the general good of the cause, it is the policy of this Society to foster and develop all types of artificial lighting. I shall make no attempt to urge the advantages of gas lighting, as they are sufficiently set forth by those whose business it is to exploit them. I shall approach the subject from another side, considering briefly, one by one, the obstacles, or handicaps, which in the past have stood, which to some extent still stand, in the path of gas lighting, tending to retard its progress, and to weaken it in its competition with other illuminants. The discussion will naturally involve some consideration of the prospect of the abatement or removal of these obstacles. I shall not name these handicaps in the order of their importance, nor attempt to classify them from that standpoint, but shall begin with the qualities of the fuel and follow along in the natural order, to the policies and practices surrounding the introduction and maintenance of the burners.

The first obstacle to good gas lighting to be considered is a lack of uniformity in the fuel delivered to the burner. This does not mean that only one quality or kind of gas should be made all over the country; generally speaking, any of the gases that are in vogue anywhere, are satisfactory, in the sense that existing types of gas burners may be adjusted to give efficient results with them. It does mean, however, that when burners are once adjusted and in use, it is highly desirable that the fuel thereafter fed to them be kept uniform. It thus becomes a problem for the individual manager in each city, or territory that is separately supplied. The modern gas burner, being a creature of small orifices and delicate adjustments, if it were endowed with the gift of tongues, and with a knowledge of what is expected of it, would cry "uniformity, uniformity!" with every molecule of its structure.

In the past, principally two kinds of gases have been general, coal gas and water gas. In recent years coke-oven gas has become an important factor with many companies. These gases differ from each other in gravity, in heating power, and in air requirement, *i. e.*, the volume of air necessary completely to burn a unit volume of the gas. Many important considerations have led the larger gas companies to equip themselves with apparatus for making two of these gases, and to distribute a gas that is a mixture of the two. Under these conditions the maintenance of a desirable uniformity in the gas, at all seasons, is not easy.

The effort to maintain a standard candlepower as the one standard quality of the gas has been the principal cause of variability in the other qualities. This standard candlepower quality, now happily in process of abandon-

ment, but still enforced in many cities by governmental ruling, or contractual agreement, can be maintained in the gas as delivered to the burners during the changing temperatures incidental to the seasons, only by varying the proportions of the gases in the mixture, or by processes of enrichment; and these changes automatically cause those variations in the other qualities of the gas which are harmful to the cause of good gas lighting. Candlepower as a quality of the gas is useful only on the open-flame burner. It has no value in the incandescent gas burner; on the contrary, the effort to maintain it introduces effects that are detrimental to incandescent gas lighting. Thus it is seen that the whole course of the development of incandescent gas lighting, since the first introduction of the Welsbach burner, has been retarded and handicapped by the enforced adherence to an obsolete and harmful quality in the gas. The least efficient, the most wasteful, type of burner has been coddled to the positive detriment of that type on which the future of gas lighting depends. It is one of the bright spots in the future of gas lighting that this incubus is in process of abatement. By common consent, the gas industry is abandoning the candlepower standard, in favor of a heat-unit standard, for the gas. In many towns this transformation is an accomplished fact; in others—and these include some of the larger cities—it may not take place for several years.

However, even with this principal source of variability removed, the maintenance of a desirable uniformity in the gas is still a question demanding the constant attention of the manager. When working to a heat-unit standard, a uniformity of air requirement and of gravity is more easily maintained than under a candlepower standard, but it will not maintain itself. It will continue to exist only as the result of unceasing vigilance. Economic and labor conditions demand, for many cities, that a fairly standard quantity—sufficient for the summer output—of coal gas be made, and that the extra quantity for the winter consumption be supplied by water gas, made only during that season. This means a gas of varying qualities, and the problem confronting the manager in such cases is how to introduce these changes with the least possible effect on the incandescent burners—how to maintain a gas calling for a nearly constant air requirement, as the proportion of water gas intermixed gradually increases, and then, after reaching a maximum, gradually decreases with the approach of spring. Some of the ablest minds in the industry are now engaged on the different phases of this question.

Again, unexpected or unforeseen conditions sometimes arise, which tend to destroy uniformity. The present shortage in the coal market, due to the great war, may be cited as an instance. This condition has forced some companies, which have been distributing water gas for years, to swing over to coal gas. In such a change the incandescent gas lights are bound to be affected, but with the absence of a candlepower standard to be maintained and with a new sense of the importance of uniformity which the modern manager possesses, even such changes

will produce a smaller detrimental effect on the gas lighting conditions than formerly.

Another source of variability, of a type that is entirely inexcusable, arises out of the manager's failure to realize the serious effect produced by sending out, even temporarily, an unscrubbed gas, or one containing constituents that normally are removed. It usually arises in this way: Some alteration, replacement, or renewal in the gas manufacturing plant is undertaken, without any provision being made for the temporary treatment of the gas during the interval that elapses between the taking out of the old installation and the introduction of the new, on the assumption that, for so short a period, a gas that is not normally treated will do no harm. This state of the managerial mind, once quite prevalent, is growing scarce. He knows now that he may, in a few minutes' time, by omitting precautions of the nature indicated, seriously affect his gas lighting business.

The candlepower standard has been an obstacle in the path of incandescent gas lighting, not only by tempting consumers to keep the uneconomical open-flame burners in use, because of the high candlepower of the gas, not only by rendering it impossible for the manager to distribute a uniform gas such as is demanded by the incandescent burner, but also by the psychological effect it has had on the gas manager himself. It has lulled him into a sense of false security. By tradition thinking largely in terms of the open-flame burner, the enforced maintenance of the candlepower standard, conserving a quality in the gas that is useful only on that type of burner, has emphasized this thought, thus measurably retarding the day, now happily dawning, when the manager faces about, and for the first time looks squarely in the face the requirements in the fuel that are demanded by a good incandescent gas lighting service. At no very distinct period in the past, all gas lighting was by the open flame. Gradually the incandescent type has replaced the open flame, but quite gradually, and by no means entirely, even to this day. The open-flame burner is indifferent to wide variations in the quality of the gas, so long as the candlepower is maintained. How natural, when a candlepower standard is in vogue, to rest comfortably in the thought that by maintaining this standard, one has done his whole duty by gas lighting! Fortunately, for the future of gas lighting, the manager now knows differently.

The demand for uniformity by the incandescent gas burner is not, however, completely met by the unbroken delivery of a gas of uniform quality. This uniform gas must come to the burner under uniform pressure. To variations in pressure are due many of the causes of dissatisfaction with gas burners. The rules of the Public Service Commissions of the several states usually provide a maximum and minimum pressure permissible at any burner, and an allowable degree of daily variation above the minimum. These provisions are seldom unreasonable. The gas manager well knows that the requirements of a satisfactory lighting service call for a variation consid-

erably less in volume than the variation these rules generally allow.

Strictly uniform pressures are possible only on high pressure systems, with a governor on each service. Pressures approaching this ideal of uniformity may be obtained on low pressure systems, such as the majority of gas distribution systems are, by utilizing a system of feeder mains, or a belt line filled with pumped gas and provided with governor stations located so as to feed into the distribution system at numerous points. Such devices, of fairly recent introduction, enable the manager to maintain more uniform pressures throughout his territory than formerly, and to do so at a less charge for capital investment. The modern tendency to carry higher pressures generally, causes automatically a smaller percentage of daily variation in the pressure at any point in the main system. These causes, in connection with a keener appreciation on the part of gas managers regarding the importance of pressure variations as a factor in the gas lighting service, are gradually removing what has in the past constituted a serious handicap.

Greater ease in maintaining a uniform gas at the burner is not the only benefit the cause of gas lighting enjoys by the abandonment of the candlepower standard. An additional advantage lies in the smaller quantity of condensable hydrocarbons in the gas. Adherence to the candlepower standard required the maintenance of a fair, sometimes a large, quantity of such condensable content, while compliance with a reasonable heat unit standard permits a material reduction of it. In a properly adjusted burner, the presence of such hydrocarbons in their normal vaporous form is unobjectionable, as they are completely consumed in the burner, but the seasonal variations in temperature—in the mains underground, in the basements, and in the interiors where lamps are located—whereby the temperatures in these three places vary so that each in its turn, may become higher than the other two—these seasonal variations bring about the condensation of part of these hydrocarbons, and its deposit in liquid form. The presence of this liquid deposit, becoming solid or semi-solid when subjected to burner temperatures, has in the past constituted a serious obstacle to a good gas lighting service. These deposits have been the cause of what is sometimes popularly called a "dirty" gas, now happily disappearing with the exit of the candlepower standard. Compliance with a heat unit standard permits of a sufficient reduction in the condensable hydrocarbons to prevent any deposit under ordinary seasonal ranges of temperature, thus securing greater insurance against those lighting troubles which these deposits cause. Here again we see one of the handicaps under which incandescent gas lighting has labored, in process of abatement.

An evil incidental to the modern forms of gas lighting, which was not so objectionable with the open-flame burner, rises out of the presence of traces of sulphur in the gas, in the form of carbon bisulphide and several obscure sulphur compounds. The ordinary methods of

gas purification, which effectively remove all traces of the ordinary sulphur compounds, do not touch these special combinations of sulphur. The burning of the gas, however, destroys them and liberates the sulphur in the form of sulphurous acid. The quantity so liberated into the atmosphere is so small as to be unobjectionable; indeed, the atmosphere of rooms lighted by gas does not show any higher percentage of atmospheric sulphur than does the ordinary atmosphere of our modern cities, which is charged with this substance to a greater extent than formerly by the combustion of solid fuels in house furnaces and manufacturing processes. However, while these traces of sulphur are negligible as vitiators of the atmosphere, their presence in the products of combustion issuing from gas burners, nevertheless, produces certain other objectionable effects which gas lighting would like to dispense with. It is a factor in increasing the discoloration of burners and fixtures, and of walls and ceilings, caused by the continual impingement of these products of combustion. If these products were absolutely devoid of sulphurous acid it is probable that the objectionable discoloration of burners and fixtures would be materially reduced.

The darkening of walls and ceilings, which constitutes one of the greatest handicaps under which lighting by gas suffers, is not caused solely by the sulphurous acid in the products. The presence of this compound, however, is a potent factor in causing it, and the complete removal of the sulphur would materially retard the growth of the stain, and also diminish its intensity. The removal from the gas of these obscure sulphur compounds is, unfortunately, not easy, and it is expensive. The subject is engaging the attention of the ablest chemists and engineers in the industry, and the outlook for the development of a feasible process of purification that will entirely eliminate them, is by no means hopeless. If gas lighting is to hold its proper rank in the field of artificial illumination, the accomplishment of this object is important.

The elimination of condensable hydrocarbons from the gas, incidental to the transfer from a candlepower to a heat-unit standard, by removing a tendency to cause smoke due to clogging of orifices in the burners, is another factor in lessening the evil of darkened walls and ceilings. Not anything that it is in the power of the gas industry to do, however, will entirely remove this objection. Caused by the impingement of atmospheric dust carried by warm air currents, this effect is seen above, or near, any object whose temperature is such as to induce currents of air. The effect is proportional to the volume of the current and the length of time during which it impinges, assuming an equally dusty atmosphere. Insofar as the gas burner generates a large quantity of heat, it cannot avoid the impingement of a correspondingly large volume of the dust-laden air. It can look for relief from this trouble, only in a reduction of the quantity of dust and dirt in the atmosphere, or by an increase in the efficiency of light production. In residences, especially those of the better class, in which this evil is more objec-

tionable than elsewhere, there is reason to expect in the future a more dustless atmosphere, due to the introduction of a gaseous house-heating fuel, to the more general use of vacuum cleaners instead of brooms, and to cleaner city streets. In passing, it is worth noting that less dust in the air in residences will have another beneficial effect on gas lighting, in that it will retard the accumulation on the burner gauzes, and thus lengthen the period between maintenance visits.

Second only to the handicap of discolored walls and ceilings, if indeed not of equal importance, are the problems of ignition and distance control. These have to do with the factor of convenience, an attribute of prime value. They are recognized as problems of fundamental importance, and there is no need for me to dwell on them in this place. Mechanical and chemical inventiveness have accomplished much in the efforts to solve them, and there is no reason to believe that the end has been reached.

An obstacle to the full development of gas lighting is a practice still followed generally by gas companies, which is based on a policy which the industry has drifted into, rather than consciously adopted. This is the practice by which the open-flame—the least efficient—burner is given away freely to consumers, while the various forms of the incandescent—the most efficient—burner are only sold at a profit. This practice places a handicap on the introduction of the incandescent burner, while obviously it is the true interest of the industry, in its competition with other forms of lighting, to facilitate the introduction of its most efficient appliances. It is not difficult to trace the path of this now mistaken policy. When all gas lighting was by the flat-flame burner, gas companies generally adopted the then liberal policy of giving these burners, without charge, to consumers. The expense was small, and the inducement to the consumer thus created was worth while. The replacement of the flat-flame by the incandescent burner has been a gradual process; the adherence to the candlepower standard has, as already explained, kept the flat-flame burner in an undeserved relative prominence; and the gas manager, as in all long established industries like the gas business, has been conservative. Thus this old practice has continued by virtue of its own momentum. Of course there was less objection to it when gas lighting, even by the flat-flame burner, was less expense than competing forms of lighting, but since this margin has grown smaller, or has disappeared, this practice has become increasingly unjustified. And yet it is generally followed to-day. Some progressive companies are now charging for flat-flame burners, and are shaping their new-business policies so as to throw every inducement in the way of the consumer to use nothing but incandescent gas burners; and there is little doubt that gas companies generally will follow suit.

The subject just considered brings us naturally to another, which is matter for serious concern to gas lighting interests. The gas industry has not shown itself able to control the quality of its incandescent lighting appliances. Inefficient, poorly designed and constructed burners, and

flash mantles, constitute a very serious evil. And yet it is only within a comparatively recent date that the industry may be said to have considered it seriously. The national societies are now wrestling with the problem of standard designs and specifications of burners and mantles. So far, within my knowledge, no gas company has thought it worth while, in order to control this situation, to make free installations of standard burners, or even of standard mantles. In time, competition may bring them to it. Some companies, however, are using all of their influence to reduce, or altogether to stop, the sale of cheap burners and mantles by storekeepers in their cities, and to encourage their consumers to purchase all of their supplies from the companies. The fact that gas mantles, of a kind, may be made by relatively unskilled labor, and in a plant requiring so small a capital investment, is a detriment to the cause of gas lighting.

Still another question of mistaken policy, inherited rather than adopted, comes to mind. It has to do with the relations between gas companies on the one hand, and plumbers and gas-fitters on the other. In order to facilitate and promote the introduction of gas cooking and other fuel appliances, gas companies generally have long followed the practice of including the connection with the sale of the appliance, and of installing the piping connection by their own workmen. Again, while many gas companies have refrained from installing in new houses at the time of their erection, the complete piping system for gas lighting, leaving this work to the plumbers, still, even in the lighting field, the desire to promote installations has led many gas companies to include in the sale of burners, any piping that may be needed to hang the burners. This piping work done by the companies, has, as a rule, cost the consumers less than the plumbers can afford to do it for. This practice has resulted in the plumbers and gas-fitters feeling that the gas company underbids them, and injures their market. Instead of every gas-fitter in town being a friend to the gas company and a promoter of gas lighting, as he should be, too often he is indifferent, or actively unfriendly. Within a recent period, the unwisdom of this situation has been appreciated, and at least one of the larger companies, within my knowledge, has adopted a policy the reverse of the traditional one.

Generally poor illuminating engineering on the part of the gas company's salesmen may be fairly cited as one of the handicaps to which gas lighting is subjected. Many causes contribute—the salesmen are paid by a method which induces them to increase their sales at any cost, or by a method which induces them to select for sale, not the burners which are best for the location, but those which return the best pay to themselves, or campaigns are undertaken, in which only one type of burner is offered, or the salesmen are insufficiently instructed in the principles and practices of illuminating engineering, or to practice illuminating engineering would require a more careful study of the conditions than the salesmen have time for. I am offering no criticism of these causes,

as many of them are unavoidable, or at times a given practice is advisable in spite of certain objections to it. It may, however, safely be said that these conditions tend to improvement. Salesmen generally are receiving more thoro instruction in illuminating engineering; they are as a class better experienced in its practice. One of the national societies has inaugurated an excellent course of instruction for them in this subject. Gas managers, largely through the influence of our own society, are more keenly alive to its importance.

During recent years there has grown a conviction in the industry, that gas companies should inaugurate systems by which their employees would visit consumers' premises to examine and maintain their gas lighting appliances. Some systems of this nature are in operation at the present time. As a description of these is the subject of a paper to be presented before this convention, I shall make no further comment except to say that the growth of a sentiment favorable to maintenance systems is a hopeful sign.

It may seem grotesque to include the backwardness of the gas industry in promoting street lighting by gas as constituting in any sense a handicap. Yet I think it is worthy of a brief consideration here, as it marks a failure properly to utilize an effective means to publicity. Publicity! Of which gas lighting stands in so much need! Any article appealing to universal popular favor, no matter how excellent in itself, cannot hope to achieve its greatest success minus this indispensable ingredient. Such is the nature of our public; it pays to advertise. And how better can the gas industry advertise its lighting product than by effective, showy street lighting? Ornamental lighting by gas, appropriate for parkways, boulevards, and the show places of cities, is entirely feasible, and if it is undertaken by gas companies as an advertisement and means to publicity, and not as a means of making money, there is reason to believe that much of it may be secured. So long as there is slight or no demand, it is natural that but few properly artistic fixtures should be available.

A condition that, in one way or another, has had a retarding effect on the progress of the gas lighting business may be expressed in the word "rates." Long accustomed to sell their product at a rate that was uniform under all conditions of use, gas men are at this day only novices at the difficult and delicate art of rate making. While differential rates for gas are of more importance to the industry in the fuel end of its business, still its slowness in utilizing this efficient means of increasing sales, and reducing costs, has undoubtedly had a retarding effect on the progress of the lighting end. A realization of this fact is spreading rapidly.

I have reserved for the last, the most serious obstacle

that threatens gas lighting to-day. As might be expected, it is an internal enemy, not one that menaces from without. It is indifference. Is the effort to promote gas lighting, to extend it in the face of active competition, especially in view of the splendid prospects of the fuel end of the business, after all worth while? For one cause or another, this paralyzing doubt is but too common among gas men. In the face of it, how can the gas lighting business expect to progress? Circumstanced as it is, nothing but positive, vigorous enthusiastic effort, exerted by men who really believe in it and are determined to make a success of it, can maintain its standing, and secure its healthy growth.

A potent cause for the unfortunate condition I am now considering, is what is known as the "combination town," where the electric and gas undertakings are controlled in one interest. I feel tempted to say that the combination town is the worst enemy that gas lighting has. In the various combination towns, as they exist in different parts of the country, one of three different policies seems to control. (1) Either the combination company does not actively push either its gas or its electric business, on the ground that having only a limited sum to devote to canvassing, it pays best to spend this sum respectively on the fuel and power ends of its two lights, because no matter what kind of light the consumer may want, "we get it anyhow;" (2) or the company frankly pushes the sale of the electric light alone, alleging that a given sum spent in canvassing in the gas field yields a far larger return in the fuel, than it does in the lighting end of the business; (3) or finally, the company actively pushes both its electric and gas lighting, sending its canvassers out in competition, as though the two were operated separately. There can be little question as to which of these courses is the best from the viewpoint of the most extensive growth of artificial illumination. It is the demoralizing effect on the gas men operating under the first two conditions, and the enervating influence exerted by these men on their fellows in the business, which are deplored.

But enough! Our catalog of the ills under which modern gas lighting suffers is ended. It must needs be a robust child to bear up under so formidable an array of troubles. It is a child of sound constitution and tenacious vitality. Many of its infantile diseases have been weathered; some of the obstacles in its path are gradually becoming less formidable; some of the causes that have stunted its growth are in process of abatement. Conscious that it is doomed to maintain a life of struggle and competition, it still faces the future with a smile on its face, and with high hope in its heart. Let us, who have at heart the welfare and growth of artificial illumination, leave with it our best wishes.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS .: PHILADELPHIA SECTION

NATHAN HAYWARD, Chairman

H. MOURADIAN, Secretary, 1631 Arch Street

NOVEMBER MEETINGS

The Philadelphia Section will hold two meetings during November,—one November 1st, a joint meeting with the Franklin Institute, at the Franklin Institute; the other, a regular meeting at the Engineers' Club, November 12th.

The speaker at the *November 1st* meeting will be W. F. G. SWANN, A.R.C.S., D.Sc., Chief of the Physical Division, Department of Terrestrial Magnetism, Carnegie Institution of Washington, and the subject, "ATMOSPHERIC ELECTRICITY."

The lecture will review the present state of our knowledge of the normal electrical field of the atmosphere and causes responsible for atmospheric ionization. The recent results obtained by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington will be reviewed. The lecture will conclude with a brief account of G. C. Simpson's theory of thunderstorms, and will be illustrated by experiments and lantern slides.

The speaker at the REGULAR SECTION MEETING on *November 12* will be WILLIAM F. JOHNSON, of the Philadelphia Electric Company, and the subject will be "METHODS OF STANDARDIZATION EMPLOYED BY A UTILITY TO INSURE ACCURATE AND DEPENDABLE MEANS FOR THE DETERMINATION OF POWER DISTRIBUTION AND CONSUMPTION."

The accuracy of the meters used in a large electrical company is vital to the proper operation and protection of that company. This paper will deal particularly with the laboratory calibration of meters. The meters used at consumer's premises, at distribution centers, and at power-generating stations and sub-stations are all calibrated in the laboratory of the Philadelphia Electric Company, and Mr. Johnson will describe the various tests made, and the means and accuracy of the calibration carried on there.

PHILADELPHIA A. I. E. E. OCTOBER MEETING ON RESEARCH

GROWTH AMONG SMALL INDUSTRIAL COMPANIES, SHORTAGE OF RESEARCHES, AND COLLEGE, COMMERCIAL, AND INDUSTRIAL LABORATORIES DISCUSSED *

The increased interest which has been taken in research by electrical engineers since the war began was manifested by the unusually large attendance at the research meeting of the American Institute of Electrical Engineers in Philadelphia on October 8, about 300 being present. Many of those attending were local engineers, but the rest of the country was well represented, especially by professors from technical colleges. Papers were presented by Dr. A. E. Kennelly, C. E. Skinner, and Major F. B. Jewett.

* This report of the Annual Meeting of the A. I. E. E. in Philadelphia, is printed from the October 13 number of the *Electrical World*.

Among the important points brought out in these papers and the discussion which followed their presentation were the growth of research among the smaller industries, the shortage of properly trained men to carry on all the investigations needed, and the fields of research to which colleges, private laboratories, industrial companies, and the Government should confine themselves. It seemed to be the consensus of opinion that the primary function of colleges should be to train men in undertaking only such research as would help in the fulfillment of this duty and would permit intellectual freedom. Scientific research and only such industrial research as would not have to be kept secret would fall in this category.

While many colleges are conducting industrial research regarding which they have to pledge secrecy, it seemed to be generally agreed that such research should be conducted by the industries themselves or by commercial laboratories. Certain investigations of general interest could be conducted advantageously by coöperative laboratories or by the Government.

Special emphasis was laid on the danger of overemphasizing the need of industrial research. It might lead men unqualified for research to enlist in such work; it might be the cause of research being started on unimportant subjects; attention might be drawn away from scientific research, which is the necessary basis for industrial research.

The opinion was expressed that where industrial research is carried on by colleges the expense should be defrayed to a certain extent by the industries benefited or else by the Government. Some manufacturers' representatives claimed that they are unable to secure the scientific advice they require from colleges. In reply to this it was contended that manufacturers do not acquaint the colleges with their problems.

Several speakers warned against giving students the impression that they should be researchers, it being the contention that scientific investigators are born and cannot be developed. It was also brought out that formulation of research problems is just as important as carrying on the research.

Correlation and coördination of scientific and industrial research to avoid duplication of effort and make the results available to the maximum number was strongly urged. This is being undertaken by the National Research Council. Many controversial problems exist which should be thrashed out once for all to avoid the necessity of

ENGINEERS' CLUB OF PHILADELPHIA

dragging along countless ideas that only make future research more difficult. It was also urged that intensive research be conducted along definite lines until conclusions are reached. Some manufacturing companies are encouraging this procedure by offering scholarships to graduate students on the condition that they enter the employ of the company following their investigations.

Among those taking part in the discussion outlined above were the following: Prof. V. Karapetoff, Capt. E. B. Craft, Prof. Alexander Gray, Dr. E. P. Hyde, L. F. Morehouse, Dr. C. H. Sharp, Prof. W. I. Slichter, Dr. Harold Pender, H. A. Hornor, Ralph Pope, Prof. Charles B. Scott, B. A. Behrend, Prof. Comfort A. Adams, Dr. William McClellan, L. W. Chubb, and W. L. R. Emmet.

At the close of the last session Professor Scott made a motion that was unanimously carried, to the effect that a special committee be appointed on research.

W. L. R. Emmet, chairman of the submarine committee of the Naval Consulting Board, addressed the mem-

bers at the banquet on "How Engineers Can Assist in the War," bringing out the point that the Government is not fully organized for research and must depend to a great extent on private research bodies. Referring briefly to the program of the Naval Consulting Board, the chairman pointed out that suggestions are being contributed by civilians, but most of the ideas are so incomplete that it is impossible to make use of them. This is due to the very small amount of time available for investigations on subjects which do not give evident assurance of success. If ideas are contributed, they should be accompanied by working drawings, specifications, and results from practical experiments.

Money is available for experimentation when the expense is justified. In fact, the National Research Council has considerable money which has been subscribed privately. A great deal of the money has been spent on the development of wireless transmission and some promising results have been obtained.



AMERICAN SOCIETY OF MECHANICAL ENGINEERS .: PHILADELPHIA SECTION



LEWIS F. MOODY, Chairman. JOHN P. MUDD, Secretary, Midvale Steel Company, Nicetown, Pa.

Program for 1917-1918.

- November 27** Program arranged by the New York Committee on Local Sections.
Mr. D. Robt. Yarnall, Chairman.
Meeting at the Engineers' Club.
- December 11** Offensive against the Submarine, by Jos. A. Steinmetz, of the firm of Janney-Steinmetz & Co.
A joint meeting with the Franklin Institute at Franklin Institute Auditorium.
- January 9** Special meeting at the Engineers' Club. Speaker, Mr. Chester Larner. Subject to be announced.
- January 22** Our Navy and the War, by Prof. Wm. L. Cathcart, United States Navy (retired).
A joint meeting with the Illuminating Engineering Society will be arranged.
- February 26** Supplement to Taylor's Art of Cutting Metals, by Carl Barth, Consulting Engineer.
Meeting at Engineers' Club.
- March 26** Recent Developments in Material Specifications, by Dr. S. W. Stratton, director of U. S. Bureau of Standards.
- April 23** Meeting at Engineers' Club.
Recent developments in the Treatment of Corrosion Problems with special reference to Iron and Steel, by A. S. Cushman, Major Ordnance Department, U. S. R.
- May 28** Meeting at the Engineers' Club.
To be announced.



TECHNOLOGY CLUB OF PHILADELPHIA



H. A. TERRELL, President.

N. A. WHITE, Secretary, Wenonah, N. J.

MEETINGS

THE next meeting of the Technology Club will be held on Wednesday evening, November 7. There will be an informal dinner at the Club at 6.30 P.M. and meeting at 8.15 P.M. Mr. Joseph Hays, typographic expert with the Lanston Monotype Machine Company, will address the Club on "Printing, Its Art and Science." The paper will also include descriptions of composing machines and type and rule casters. Mr. Hays was formerly secretary to the Boston Typothetæ and to the Philadelphia Typothetæ and is a former chairman of the American Cost Commission. The paper will be illustrated with lantern slides, and discussion of the paper is invited. Members of the Engineers' Club and Affiliated Societies are invited.

At the December or January meeting Dr. Hollis Godfrey, 1898, president of Drexel Institute, will speak on the work of the National Council of Defence, of which he is chairman.

OCTOBER MEETING ON NATIONAL SERVICE

At the October meeting the Club was honored by the presence of Professor Pearson, from the Institute; Mr. James P. Monroe, 1882, vice-chairman of the Federal Board for Vocational Education and chairman of the M. I. T. Committee for National Service; Mr. John M. De Bell, 1917, in charge of the Washington office of the M. I. T. Committee, and Mr. Paul C. Leonard, 1917, chairman of the Managing Board of the "Tech."

Mr. Monroe told of the work of the M. I. T. Committee for National Service, which has taken over the duties of the original committee in connection with the mobilization and census of the alumni. This census was complete and at the service of the Government on the day war with

Germany was declared. A Washington office is maintained by the committee as a means of communication between the various Government branches and Technology alumni, and a complete roster of the Technology men and women in the National Service is being prepared. The Technology women have been organized and a work-room for their use opened in the Rogers Building in Boston. The committee has been active in providing for the comfort of the men in France, and the Technology Club of Paris was the first club of its kind to be established by an American university.

This Club, established primarily for the benefit of Institute men in service abroad, will be merged in the American University Union now being started by representatives of various American colleges.

Mr. Leonard spoke of the work of the student paper, the *Tech*, which has become an alumni as well as a student organ. The *War-Time Tech* will give news from the alumni organizations and accurate condensed information from headquarters at Washington and Paris. If you are not a subscriber, send \$1.50 to Mr. C. A. Anderson, '05, chairman of the local committee, 327 Commercial Trust Building, Philadelphia, and you will receive the *Tech* twice a week for six months.

Moving pictures taken at the Technology Training Camp at Camp Cunningham, Maine, were shown for the first time, and the camp life was described by Mr. De Bell. This camp was maintained for the undergraduates during the summer months.

Professor Pearson told of the work being done by the men in the service, and gave examples of the difficult problems which have been solved. Chemists, especially, have been in great demand, many of the men having been engaged on problems in connection with gas defense.

PHILADELPHIA ASSOCIATION OF MEMBERS AMERICAN SOCIETY OF CIVIL ENGINEERS

At the annual meeting of the Philadelphia Association of Members of the A. S. C. E., held at the Engineers' Club of Philadelphia, on October 1, 1917, the following officers were elected:

President, to serve one year:

Henry H. Quimby

Vice-President, to serve two years:

John Meigs

Directors, to serve two years:

W. L. Stevenson

John F. Murray

Treasurer, to serve two years:

S. M. Swaab



SOCIETY OF AUTOMOTIVE ENGINEERS PENNSYLVANIA SECTION

JOHN W. WATSON, Chairman

A. K. BRUMBAUGH, Secretary, Autocar Co., Ardmore, Pa.



PENNSYLVANIA SECTION OF THE SOCIETY OF AUTOMOTIVE ENGINEERS TO LAUNCH UNIQUE PLAN

THE Pennsylvania Section of the Society of Automotive Engineers, holding its meetings at the Engineers' Club on the last Thursday of each month, this year is putting into effect a unique plan calling for concentration on one broad subject for the year's meetings.

In past years the Pennsylvania Section has gone along in a more or less haphazard way. At one meeting there would be a paper on the "Otto *versus* the Constant Pressure Cycle"; jumping at the next meeting to a paper on "Ignition" and then to "Pneumatic Tires," and still to some other totally unallied subject. While papers selected thus at random did good, they really failed to develop any data of material benefit to the industry.

The subject selected for this year will be "The Elements Affecting the Riding Qualities of a Motor Vehicle." Each month the Section will take up one of these Elements. Among the Elements taken up will be such subjects as "Springs," "Tire Sizes and Pressures," "Relation of Sprung to Unsprung Weight," "Distribution of Weight," etc.

Each paper dealing with one of these Elements having an effect upon the riding qualities of a motor vehicle will be read by the highest authority on that particular subject. The final meeting this year will be devoted to a review of the former meetings and will be in the nature of a summary of all the Elements, and the Section looks forward to being able to hand over to the industry the most authoritative and up-to-date information on this broad and vital subject. The question of shock absorbers and other attachments not Elements in the construction of the car will be taken up probably at the meeting immediately preceding the final meeting. After a study of all the Elements proper it may be found that without some form of auxiliary attachments it will not be possible to obtain the desired riding qualities. It will thus be the work of the Section to determine just what class of auxiliary attachments are necessary to correct the deficiencies or limitations of the Elements proper.

The ideal to be striven for is a car body which will maintain straight-line travel regardless of road condition

and of car speed. It is doubtful if this ideal ever will be made fully possible, but concentration on this subject will undoubtedly lead to a closer approach to the ideal than is shown by the average car of to-day.

The first paper will be given on Thursday evening, October 25, by Mr. Walter C. Keys, of the Perfection Spring Division of the Standard Parts Company of Cleveland. Mr. Keys's paper will be "Spring Design and Construction as Affecting Easy Riding." Mr. Keys is looked upon as probably the highest authority on this subject in the country. His research work has been extremely thoro and of a most practical nature. It is understood that Mr. Keys is the originator of the photographic system for recording and charting running gear and body movements encountering various forms of road obstacles at various speeds. The paper will be illustrated by slides or by moving pictures.

Invitations to take part in the discussion have been sent to Mr. John Wilkinson, of the Franklin Company; Mr. Nadin, of the Rolls-Royce Company; Mr. Behn, of the Hudson Company; Major Howard Marmon, and other engineers, each of whom is a strong advocate of some one of the different spring designs, such as full elliptic, cantilever, flat semi-elliptic, etc.

"Good riding qualities" must not be looked upon as merely a luxurious condition for passenger cars. Good riding qualities mean a great deal more than that. If the frame and body of a passenger car or of an ambulance or motor truck can be maintained in straight-line travel it will be found that these vehicles will be far more economical to operate and maintain and that a great many more miles can be covered in a given time with less fatigue to the driver, occupants, and entire mechanism. Engine vibration is a powerful agent of destruction, but so also are the jarring and bouncing and side-swaying of the sprung portion of a vehicle.

The Pennsylvania Section of the Society of Automotive Engineers is pleased to extend an invitation to all members of the Engineers' Club to be present at these meetings.



AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

EASTERN PENNSYLVANIA CHAPTER

GEORGE W. BARR, President

GEORGE BOON, Secretary



ON October 11, at 8.15 P.M., the first regular meeting of the season was called to order by President Barr, with 60 members and guests in attendance.

After satisfactory reports from all standing and special committees, the President was authorized by unanimous vote to appoint a committee of three to confer with a committee of architects to devise means of establishing a closer relation between Heating and Ventilating Engineers and architects and their clients.

The invitation of the Illuminating Engineering Society to hold a joint meeting Friday evening, October 19, was read and accepted, and many members expressed their intention to attend. The special committees of

affiliated societies in charge of these joint meetings appeal to individual members for their coöperation.

Four applications for membership were received and the applicants were unanimously elected to full membership.

The very interesting paper, entitled "General Utilization of Pulverized Coal," by H. G. Barnhurst, was read by H. R. Collins, of the Fuller Engineering Company. Illustrations of the novel and successful applications in varied industries were shown and discussed by Messrs. Jellett, Nusbaum, and Anderson.

At the next regular meeting, November 8, the subject of "Fuel Conservation" will be considered from the standpoint of the producer.

THE WAR COMMITTEE OF TECHNICAL SOCIETIES

A COMMITTEE has been organized by the Engineering Council, known as The War Committee of Technical Societies, with headquarters at No. 33 West Thirty-ninth Street, New York City.

In a circular letter sent to members of the various societies it has been pointed out that the function of this committee will be to act as the intermediary or means of communication, when desired, in matters relating to Science, Research, Invention, and Engineering between the Army and Navy, the various Boards, Councils, Committees, and other agencies of the Government and the membership of the societies represented, for the purpose of presenting problems in Science, Research, Invention, and Engineering to the members of the Technical Societies, and of obtaining their ideas and suggestions.

A pamphlet, issued by the Naval Consulting Board, dealing with the submarine problem, has recently been mailed to all members of the various national societies. This pamphlet has attracted wide attention. In simple and plain words it tells just what fields of invention are apparently hopeless to combat the submarine and what others offer better possibilities.

It is apparent that the Naval Consulting Board has had thrust upon it thousands of suggestions and plans advanced by people from all over the country. Many misguided persons, hearing of the enormous wealth accumulated by owners of successful patents, are ready to spend their savings in trying to invent improvements on machinery about which they know nothing. At the same time, bearing in mind the old maxim that fools may ask

questions that wise men cannot answer, ideas may be advanced which might, in the hands of capable and experienced engineers, result in effective means of accomplishing the desired object. Such ideas on the subject may be communicated to the secretary of the Naval Consulting Board, Thomas Robins, No. 13 Park Row, New York City, N. Y.

Copies of the pamphlet, entitled "The Submarine and Kindred Problems, Bulletin No. 1," may be obtained upon application to the New York City office, No. 33 West Thirty-ninth Street.

The personnel heading the various committees is as follows:

J. M. Boyle and J. B. Davies, American Society Civil Engineers.

A. M. Greene Jr., and R. N. Inglis, American Society Mechanical Engineers.

D. W. Brunton and Edmund B. Kirby, American Institute Mining Engineers.

C. R. Corning and G. C. Stone, Mining and Metallurgical Society of America.

Joseph Bijur, American Electrochemical Society.

A. S. McAllister and H. W. Buck (chairman), American Institute Electrical Engineers.

Edmund B. Kirby, Secretary, No. 33 West Thirty-ninth Street, New York City, N. Y.

The American Chemical Society and the Society of Automotive Engineers will join the Committee as soon as their Directors have had an opportunity to take official action.

ENGINEERS' CLUB OF PHILADELPHIA

EXPERIENCED HIGHWAY CONSTRUCTION MEN FOR SERVICE IN FRANCE

(Continued from Page 526)

at West Point at the head of the class of 1901. After service on road and bridge work in the Philippine Islands and river and harbor work in the United States, he served as an instructor at West Point and as an assistant to the Chief of Engineers at Washington.

The first two battalions are commanded by Majors I. C. Moller and Henry H. Stickney. Major Moller received his engineering education in France. He has been engaged exclusively in highway work for the last ten years, and for three years has been chief engineer for an American company doing road work in all parts of the world. In this capacity he has been called upon to act as consulting engineer for the governments of almost every Central and South American republic.

Major Stickney was educated at Clarkson College of

Technology, Potsdam, N. Y. Since 1906 he has been engaged on state highway work in New York and on the New York State Barge Canal. He has also had considerable experience as consulting engineer in road and water-supply construction. He is a graduate of the Engineer Officers' Training School at Fort Leavenworth and a member of the New York State National Guard.

Captain F. S. Skinner, regimental adjutant, is a graduate of the United States Military Academy. Thus the regiment will be under the direction of those who have fully demonstrated their ability in highway and construction work.

Full information regarding steps that must be taken to enlist in this regiment may be secured from the Commanding Officer, 23d Engineers, National Army, 1419 F St., Washington, D. C., by mailing the following information to him.

Fill in This Form, by Typewriter if possible, and Mail To-day, to

COMMANDING OFFICER, 23rd ENGINEERS, NATIONAL ARMY,
1419 F Street, Washington, D. C.

(1) Name (2) Address
(3) Age (4) Nationality
(5) Married or single (6) Have you been called in the draft?
(7) Will you enlist for the period of the War? (8) State briefly your road-building or other construction experience
(9) What machinery can you operate?
(10) Your present or a former employer must certify to your qualifications by signing here
SIGNATURE OF EMPLOYER EMPLOYER'S ADDRESS FOR TELEGRAMS

SECRETARY'S NOTICES

(Continued from Page 521)

been taken in designing the general layout to provide suitable fire protection, smoke-proof fire tower, anti-draft doors, etc.

The Building Committee had available for use approximately \$15,500, and the preliminary estimate of immediate expenditures is as follows:

Heating plant (both houses, first floor).....	\$1,570.00
Vault light deck (roof over dining-room, etc.).....	2,000.00
Cold-storage building	2,000.00
Cold-storage plant—(refrigerating machinery)	1,850.00
Alterations and additions to dining-room, kitchen, office, etc.	5,220.00
Furnishings for kitchen and dining-room, including kitchen equipment, linens, china, silverware, etc..	2,860.00
Total	\$15,500.00

To complete the entire work on the first floor, including new lobby, parlor supporting columns for auditorium girder, etc., \$3000.00 to \$4000.00 will be required in excess of the sum of \$15,500.00 now available.

We understand that the Building and Equipment Fund is being gradually and steadily increased, and we hope, before the construction above outlined is well under way, to have enough additional funds available to complete the entire first floor.

The report was unanimously approved, and the meeting adjourned at 9.10 P.M.

H. A. STOCKLY,
Secretary.

ELECTRIC CODE

(Concluded from Page 514)

them as live wires of the same voltage because of their liability to come in contact with the live lines.

Never change the strains on a pole by adding or removing wires until assured that the pole will stand the altered strains.

In stringing wires do not allow them to sag so as to endanger vehicles or pedestrians below, unless traffic is intercepted by watchman or otherwise.

487. Reporting Defects

Report promptly to your immediate superior any dangerous conditions of your own or other utilities observed arising from defective insulators, pins, cross arms, abnormally sagging wires, etc.

Underground Line Operation

All cable splicers and other workmen in underground construction or operation shall study and strictly observe the following in addition to the general rules in sections 42 to 46, which apply to their work.

490. Guarding Manholes, Handholes, and Street Openings

When removing manhole or handhole covers or making excavations, promptly protect the opening with a barrier, temporary cover, or other suitable guard, and see that danger signals or red lights are displayed in a location conspicuous to the traffic until permanent covers are in place or the excavations are filled.

491. Testing for Gas

Do not enter manholes until you have assured yourself that the manholes are free from dangerous gases, by testing with approved safety lamps, by ventilation, or by other adequate methods. (See rule 581.)

492. Watchman on Surface at Manholes

Do not enter a manhole unless a temporary cover is placed over the opening or a watchman is stationed at the surface. Where any gas is liable to be present always see that the watchman is stationed at the surface. Where any hazard is involved do not leave a manhole unwatched until all workmen are out.

493. Avoiding Flames

Do not smoke in manholes and avoid as far as practicable open flames or torches in or near manholes.

Avoid sparks in handling live parts or cable sheaths and avoid igniting the flux in soldering and wiping joints. In using hot paraffin see that it does not reach a temperature, at which it will ignite. (See rule 583.)

494. Pulling Cables

When pulling in cables make sure that the gear can not slip so as to injure workmen. Avoid the danger of having the hands drawn into the tackle by the pulling line.

495. Testing and Splicing Live Cables

If lines and cables are not properly identified by markings or positions, do not work upon them.

Always ascertain, if practicable, whether cables are alive, by testing with the test devices provided, before cutting into the cable sheaths. Live cable should be spliced only by men experienced in the work, and they should use extreme caution and suitable devices in so doing.

496. Reporting Defects

Promptly report to your immediate superior any dangerous condition of your own or other utilities, whether observed in underground or overhead construction. Particularly report insanitary conditions, gas or missing cable tags in manholes, and abnormally sagging wires or broken supports in overhead construction.

Series Lamp Operation

All series lamp trimmers, hangers, and inspectors shall study and strictly observe the following, in addition to the general rules in sections 42 to 46, and the special rules under the sections for overhead and underground operation, respectively, in sections 48 and 49, which apply to their work.

500. Precautions on Series Circuits

Series lamps and devices in series circuits should always be treated as alive unless disconnected by absolute cut-outs or protected by the grounding of the circuit (see section 46).

501. Handling Series Lamps

Trimmers, inspectors, or patrolmen shall wear suitable insulating gloves and stand on insulating platforms or dry, well-seasoned wood poles while touching series lamps or their cut-outs, when these are alive.

Where stools or tower wagons are used which provide sufficient insulation from ground for the voltages to be handled, the insulating gloves may be dispensed with.

502. Bridging Series Lamps

Before working on lamps or other devices in live series circuits always bridge the device with jumpers such as series lamp cut-outs usually provide, so that the circuit cannot be opened at the device and possibly be completed through your body or arc at the point of opening and burn you.

503. Testing Series Lamp Circuits

Series lamp circuits should not be tested at their full operating voltage unless it is impracticable to test otherwise. Tests should be made only in accordance with a time schedule, concerning which all persons whose safety may be affected are informed.

504. Periodically Disconnected Circuits

If circuits, such as series lamp circuits, are not effectively grounded during the idle period, all rules for handling live parts shall be strictly observed.

505. Reporting Defects

Report promptly to your immediate superior any abnormally sagging wires, broken insulators, leaning poles, defective pole steps, broken globes or lamp supports, and other defects giving rise to a dangerous condition of your own or other utilities, or any indication of voltage on lines supposed to be dead.

Sec. 51. Meter Operations

All meter setters and testers shall study and strictly observe the following in addition to all the general rules in Sections 42 to 46 which apply to their work.

510. Taped Joints

Never leave joints or loose ends of wires untaped unless otherwise protected.

511. Care About Live Parts

Do not use bare fingers or hands to determine whether a circuit is alive. Never remove or replace fuses in live circuits above 750 volts except by means of the suitable appliances provided.

512. Opening Circuits at Switches

Special care should be exercised in opening circuits at meter connections unless the circuits have been first properly opened at switches.

513. Current Transformers Secondaries

Before working on an instrument or other device in a current transformer secondary circuit always bridge the device with jumpers, so that the circuit can not be opened at the device. Never open such a circuit at meter connections until it has been elsewhere bridged.

514. Special Tools

Use only hand tools suited to the work in hand, and so reduce the danger of short circuits.

515. Reporting Defects

Promptly report to your immediate superior any live meter case or any condition of a meter or its connections of the interior wiring or of overhead lines, of your own or other utilities, which might endanger life and property.

Testing Operations

All electrical testers, helpers, and others working about electrical tests shall study and strictly observe the following in addition to all the general rules in sections 42 to 46. Owing to the diversified character of testing work this study should usually extend also to the special rules in sections 47 to 54.

520. Authorization for Work

Do not work on or about equipment or lines without first receiving authorization from the person in charge.

If such equipment or lines are under control of a chief operator, this authorization must come from him. This will include the attaching of tags at the proper points and the observation of all rules for general operation in Section 43.

521. Checking of Conditions

Thoroughly familiarize yourself with all conditions surrounding equipment or lines to be tested before making any change in these conditions.

Do not make any change in equipment or lines unless you fully understand the effect of the change.

522. Foreman

One properly qualified person shall be in immediate charge of all testing work, or all of the workmen shall be instructed as to the work they are to perform and the employee instructing them shall be considered in charge of the work.

523. Warnings and Barriers

Display danger signs and erect suitable guards about all equipment or lines under test when in places where traffic is frequent, if live or moving parts would otherwise be exposed.

When temporary wiring, belts, pulleys, or other temporary live or moving parts must be guarded, suitable portable guards and warning signs shall be used.

524. Requirement for Two Workmen

No person should work alone in testing or experimental work on or about parts on which the voltage can exceed 750 volts, except in routine testing where the live parts are properly guarded.

525. Reporting Defects

Promptly report to your immediate superior any conditions of equipment or lines under test which may endanger life or property.

Tunnel and Subway Operation

Tunnel and subway electricians, operators, and others working on or about underground electrical equipment (not in stations, substations, or in underground conduit systems) shall study and strictly observe the following, in addition to the rules in sections 42, 43, 44, 47, and 49, so far as they apply to their work.

Dangerous Locations.—The value of insulation (insulating covering) as protection from shock is reduced by the dampness usually present in these and similar locations. The restricted spaces often bring the worker closer to equipment and wires than in other kinds of electrical work, and the imperfect illumination also makes special care necessary to avoid contacts. The human body and all surrounding surfaces become more conducting where dampness exists, and electrical shocks are therefore more severe.

530. Live Electrical Parts

Before handling any electrical equipment or wires, make sure whether they are alive or dead. It is not advisable to work on live equipment or wires when the current can be shut off without interrupting necessary operations.

Never touch or disturb any electrical equipment or wires without being authorized.

531. Standing on Ground

Do not touch any electric wire, cable, or third rail, no matter how well it is insulated, while you are standing on the ground or on any pipe, track, rail, or other conducting surface, unless insulated from the latter.

Do not touch the metal frame or case of a motor unless you are insulated from the ground or the frame is effectively grounded.

Remember that the surfaces of damp ground and water are conducting. Insulation on a wire may look perfect, but it can not be relied on to prevent shock.

532. Carrying Tools

In carrying tools or metal implements in passageways containing electric wires, especially near exposed trolleys, never permit the tools or implements to touch them.

In particular, do not carry such objects on the shoulder when there are conductors overhead. Do not carry objects on that side of passageways where third rails or side trolley wires are exposed.

533. Handling and Repairing Live Parts

When necessary to handle or repair live trolley wires, third rails, cables, motors, or other electrical equipment, wear suitable insulating gloves or stand on the waterproof insulating mats or platforms provided.

Do not rely entirely on gloves for protection. The gloves may have been punctured since they were previously tested.

Before handling or making use of any electrical cable, carefully examine it to make sure that its insulation is not injured.

Portable cables should be inspected at least once daily during the period of their use.

534. Handling Portable Devices

In handling portable motors or lamps, first make sure that the external metal frame is not alive by contact with or leakage from live parts within.

Have such portable devices inspected at least once daily during the period of their use.

535. Fuses and Switches

Never handle fuses or close switches or circuit breakers unless you are authorized to perform that special duty, and then use the insulating handles or rods provided.

Before closing switches first make sure that you are not endangering other persons.

536. Injuring Cables and Wires

Do not fire shots, handle tools, or perform other work in such a manner as to injure cables or wires in the vicinity. If in doubt, consult your superior.

537. Temporary Wiring

Never arrange the wiring of any temporary circuit for earth return, nor use bare conductors.

This particularly applies to the temporary portions of shot-firing circuits and to the leads of portable motors and lamps.

Never employ temporary circuits without seeing that there are installed at the junction with the permanent wiring, suitable disconnecting switches or plug connectors, arranged to disconnect all conductors of the temporary circuit by a single operation.

For shot-firing circuits their disconnectors should be left open until the shot is to be fired, and should preferably be arranged for locking in the open position.

538. General Precautions

Never get on or off locomotives or cars on the side where the trolley wire or third rail is located.

Do not place combustible or explosive materials near electric wires, trolley tracks, third rails, or motors.

Do nothing that will cause sparking, or expose parts that may arc or spark during operation, if any explosive gases are present.

539. Reporting Dangerous Conditions

Promptly report to your superior any dangerous or unusual conditions observed. In particular, report the presence of gas, broken insulators, bad insulation on wires, defective third-rail construction, live frames of motors, broken ground wires on motor frames, and sparking, arcing, or shocks noticed at any point.

Report also any fallen, crossed, or abnormally sagging wires, whether electric wires or not. This includes trolley wires at switches and crossings and wires injured thru falling roofs.

Signal Line Operation

All men working on or near telephone and telegraph lines operated in connection with supply lines shall study and strictly observe the following, in addition to all the general rules in sections 42, 43 and 44, and the special rules in sections 48 and 49, which apply to their work. For rules governing the operation of commercial signal lines see sections 55-58.

540. Official in Charge of Operations

In those rules where the words "chief operator" are used the official in charge of safeguarding operation is to be understood.

541. Precautions Before Climbing Poles

Before climbing poles or other structures to work on or about signal lines, especially where occupied in common with, or running near power circuits, make a careful inspection to ascertain if possible whether there are any crosses with supply circuits.

Apply mechanical tests as far as practicable to messenger wires before trusting the wires to carry your weight.

542. Approaching Supply Lines

Avoid contact with all wires other than those you know to be signal wires, assuming such other wires always to be alive. Signal wires in trouble may be in contact with

supply lines at some distant point and should be treated with proper care.

Do not approach any supply line or supply equipment within the distance given in rules 441 and 442, unless you comply with all the rules under that section, as far as they apply.

543. Touching Equipment

While handling signal lines, metal sheaths, or signal equipment avoid touching guy or span wires and supply lines or equipment. Especially avoid standing on or touching transformer cases, hangers, or connections.

While touching open signal lines avoid contact also with grounded parts such as sheaths and ground wires.

544. Stringing Wires

When stringing wires or cables over or under supply lines, avoid any possibility of their coming in contact. Do not string them above live supply lines where it is practicable to avoid it.

Where liability of contact can not be entirely avoided, the lines being handled shall be treated as alive (unless they are effectively grounded), and the rules in section 44, so far as they are applicable, shall be carefully observed.

545. Reporting Dangerous Conditions

Promptly report to the proper official abnormally sagging wires, broken or defective insulators, pins, cross-arms, defective poles, or any other dangerous conditions of your own or other utilities.

RULES FOR COMMERCIAL TELEPHONE AND TELEGRAPH SYSTEMS

These rules apply also to fire and police alarm systems, district messenger systems, and other signal systems not operated in connection with supply lines. For rules on the latter see section 54.

RULES FOR THE EMPLOYER—SIGNAL SYSTEMS

550. Distribution and Enforcement of Rules

(a) The employer shall furnish to each regular employee working on or about commercial telephone or telegraph equipment or lines safety rules governing his conduct while so engaged, and shall take suitable means to secure the employee's compliance with the same.

(b) The safety rules furnished to any employee may be in such form as the employer may determine are best suited to the needs of individual employees. They shall, however, include the principles set forth in the following rules, or at least such part thereof as is applicable to the work in which the employee is engaged, and shall not conflict with these rules.

(c) If a difference of opinion arises with regard to the meaning or application of these rules, or as to the means necessary to carry them out, the decision of the employer or his authorized agent shall be final, subject to an appeal (if taken) to the regulative body having jurisdiction.

551. Address List and Emergency Rules

The rule books should contain or be accompanied by the following:

(1) A list of names and addresses of those physicians and members of the organization who are to be called upon in emergencies.

(2) A copy of rules for first aid, resuscitation, and fire extinguishment.

These should also be kept in conspicuous locations in central stations, on line wagons, and in other locations where the number of employees and nature of the work warrants.

552. Instructing Employees

Employees regularly working on or about signal equipment or lines, if their duties render such training necessary, shall be thoroughly instructed in approved methods of first aid, resuscitation, and fire extinguishment, and if advisable regularly drilled.

Groups of employees, such as commercial telephone operators, shall be thoroughly drilled to make prompt and orderly exit from buildings in case of fire.

553. Qualifications of Employees

The employer shall use every reasonable means and precaution to assure himself that each employee is mentally and physically qualified to perform his work in accordance with these rules, and that he is not addicted to the use of intoxicants and habit-forming drugs.

554. Protective Devices

There shall be provided in conspicuous and suitable places in stations and on line wagons a sufficient supply of suitable protective, first-aid, and fire extinguishing equipment to enable employees to meet the requirements of these rules. Such devices and equipment shall be inspected or tested to insure that they are kept in good order. The following is a list of suitable devices and equipment, the kinds and numbers of which will depend on the requirements of each case: (a) First-aid outfits; (b) insulating wearing apparel, such as insulating gloves, boots, and shields; (c) safety belts; (d) fire-extinguishing apparatus.

GENERAL RULES FOR THE EMPLOYEE—SIGNAL SYSTEMS

560. Heeding Warnings, Warning Others

Employees should cultivate the habit of being cautious, heed warning signs and signals, and always warn others when seen in danger near equipment and lines.

561. Inexperienced or Unfit Employees

No employee shall do work for which he is not properly qualified on or about equipment or lines, except under the direct supervision of an experienced and properly qualified person.

562. Electrical Supply Equipment or Lines

Workmen whose duties do not require them to approach or handle electrical supply equipment and lines should keep away from such equipment or lines.

Electrical supply equipment and lines should always be considered as alive unless positively known to be dead.

563. Safe Supports and Safety Belts

(a) *Safe Supports*.—Employees should not support themselves on any portion of a tree, pole structure, lamp bracket, or similar fixtures on poles, scaffold, ladder, roof, skylight, or other elevated structure without first making sure that the supports are strong enough, reinforcing them if necessary.

Portable ladders should be in a safe position before being climbed. The slipping of a ladder at either end should be carefully guarded against, especially where the surfaces are smooth or vibrating.

Insecure makeshift substitutes for ladders should not be used. An employee should never trust his weight on thin wooden boxes, sinks, wash-bowls, window shelves, or chair backs.

A ladder should not be placed upon a box, barrel, or other movable or insecure object.

Care shall be taken to see that chairs, rolling ladders, and similar equipment are in first-class condition before being used.

(b) *Safety Belts*.—Employees should not work in elevated positions unless secured from falling by a suitable safety belt or other adequate means (sometimes including suitably located pole-steps). Before an employee trusts his weight to the belt, he should determine that the snaps or fastenings are properly engaged and that he is secured in his belt.

(c) *Safety Ropes*.—Ropes used for supporting boatswains' chairs, platforms, or for other purposes on which the security of the employee depends shall be frequently inspected to assure that they are maintained in good condition.

564. Duties of Foreman

(a) Each foreman in charge of work (see rule 406) shall see that the safety rules are observed by the employees under his direction. He shall make all necessary records; reporting to his superior when required. He shall permit only authorized persons to approach places where work is being done.

He shall adopt such precautions as are within his power to prevent accidents, and prohibit the use of any tools or devices not suited to the work in hand or defective.

(b) The qualified person accompanying uninstructed workmen or visitors near electrical equipment or lines shall take precautions to provide suitable safeguards and see that the safety rules are observed.

565. Handling Live Parts

No employee should touch, with bare hands, any exposed ungrounded live part above 150 volts to ground, unless he is insulated from other conducting surfaces, including the ground itself. When employees must touch, at the same time, two parts between which a considerable potential exists, insulating gloves or other protection shall be used.

566. Power Circuits in Central Offices

When making repairs on electric light or power circuits, the circuits shall, whenever possible, be made dead.

Where practicable, moving apparatus, as for example, fans, shall be stopped before working upon it.

None other than duly authorized persons shall be admitted to central office transformer vaults or battery rooms.

Care shall be used while working on or near circuits over 150 volts to ground, particularly in alternating current districts.

567. Handling Fuses or Brushes

When working on the brushes of a machine in operation, employees shall use care not to break a circuit, the flashing of which may injure the eyes or burn the hands. If it is necessary to remove a brush from the holder, the machine shall be shut down.

When inspecting or changing fuses, care should be taken to prevent injury to the eyes. If it is necessary to handle the fuses, the circuit should be cut off, if possible.

568. Battery Room

Do not smoke or cause arcing in storage-battery rooms. The use of open flames should be avoided, especially while the cells are gassing, and should be permitted only in special cases under the direct supervision of an experienced person and after the room has been thoroly ventilated.

SPECIAL RULES FOR OVERHEAD LINE OPERATION—SIGNAL SYSTEMS**570. Testing Structures Before Climbing**

Before climbing poles, ladders, scaffolds, or other elevated structures first assure yourself that the pole, ladder, scaffold, tree, cross arm, messenger wire, cable car, or boatswain's chair, or other elevated support is strong enough to safely sustain your weight.

On pole replacement work no pole shall be climbed for the purpose of clearing it of all wires and cables without first guying or bracing the pole securely.

Where poles or cross arms are apparently unsafe from decay, or unequal strains of wires on them, they should be properly braced or guyed, if necessary, before they are climbed.

An uncoiled hand line, rope, or wire of any sort should not be fastened to the employee while climbing a pole, but where this must be done the employee should exercise due care to prevent the line from catching on obstructions.

In climbing poles careful watch should be kept for nails or other foreign attachments which might catch in the clothing and cause a fall.

571. Use of Pole Steps

When poles are stepped, make use of such steps in climbing, first making sure that the steps are firmly set in solid material before trusting one's weight upon them. Pay particular attention, on icy poles, to each step.

Do not support yourself by pins, brackets, or conductor wires.

572. Spurs

Spurs with gaffs worn short shall not be used. The gaff on spurs shall be kept sharp, and spurs shall fit properly. Spurs shall not be worn on work for which they are not required, nor while men are travelling to or from work.

573. Approaching Supply Lines

Avoid contact with all wires other than those you know to be signal wires, assuming such other wires always to be alive. Signal wires in trouble may be in contact with supply lines at some distant point, and should be treated as live supply lines unless known to be free from any dangerous voltage.

Do not approach any supply line or supply equipment within the distances given in rules 441 and 442 under section 44, unless you comply with all the rules under that section.

574. Touching Equipment

While handling signal lines, metal sheaths, or signal equipment, avoid touching trolley or arc lamp span wires and supply lines or equipment. Especially avoid standing on or touching transformer cases, hangers, or connections.

575. Care About Electrical Supply Lines

Do not go among any wires until you know their voltage.

Leaning over and crowding thru unprotected supply wires should be avoided wherever possible. Place yourself so that you will not be liable to fall on supply wires should an accident occur.

Do not depend on the insulating covering of wires, and treat all lines as alive unless they have been killed properly (except signal lines known to be clear).

Treat also as alive all wires (unless thoroly grounded) which are being strung near supply lines; regard them as being of the same voltage as the supply lines.

Avoid use of hand lines or measuring tapes containing metal strands.

When necessary to work in the vicinity of supply lines, transformers, and similar equipment, assure yourself before starting work that the position of the body is such that should you momentarily forget yourself or fall no portion of the body will come in contact with the foreign wires or equipment. Have the supply lines approached killed where possible.

Railway span wires, pull offs, and trolley brackets shall be treated as if alive, even though equipped with strain or other insulators.

576. Stringing Lines

Never string wires near live lines except by means of suitable insulating hand lines or other appliances.

Avoid the use of wire or twisted pair as a substitute for a hand line.

Wires should not be strung above live lines operating at over 750 volts, unless the wires being strung are effectively grounded or otherwise suitably protected, or in handling them all the precautions are observed as provided in rules 441 and 442, for work on parts at the voltage of the lines concerned, and the spacings maintained.

Never change the strains on a pole by adding or removing wires until assured that the pole will stand the altered strains.

When wires are being pulled up on corner poles employees should stand in such a position that they can not be struck by the wire in case it slips.

Where it is necessary to remove signal wires below which are supply lines, power should be shut off of the supply lines where possible, and if this is not practicable, rope cradles and suitable guards should be erected. Extraordinary care should be exercised to prevent the signal wires from sagging into the supply lines.

When running wires, cables, cable strand, span wires, or guys across streets, sidewalks, or highways, the coil or reel shall not be left unattended, nor shall the center of any span be permitted to sag sufficiently to come into contact with vehicles or pedestrians unless a helper is stationed to warn passers-by until the slack can be removed.

When stringing wires for long distances, precaution shall be taken to prevent the possibility of vehicles or pedestrians coming into contact with the wire at the intersecting streets or highway crossings.

577. Protecting Traffic

When working overhead, keep tools and materials not in use in proper receptacles; tools or materials should not be thrown to or from the man on the pole, but should be raised or lowered by means of a hand-line, using a proper receptacle. Also tools and loose materials should not be left at the top of poles, ladders, or other elevated structures.

Workmen shall not stand where they are liable to be struck by materials dropped by men working overhead.

Pole holes and obstructions shall be protected by watchmen or by suitable guards and danger signals or lights in a location conspicuous to traffic.

When working overhead or hoisting or lowering materials above places where traffic occurs, a man should be stationed to warn passers-by.

Where traffic is light, warning signs may be used in lieu of watchmen. Where traffic is congested, it may be necessary to rope off the space.

578. Reporting Dangerous Conditions

Report promptly to your immediate superior any dangerous conditions of your own or other utilities observed arising from defective insulators, pins, crossarms, abnormally sagging wires, etc.

Any imminently dangerous conditions shall be guarded until they can be made safe.

**SPECIAL RULES FOR UNDERGROUND LINE
OPERATION—SIGNAL SYSTEMS**

580. Guarding Manholes, Handholes, and Street Openings

When removing manhole or handhole covers or making excavations, promptly protect the opening with a barrier, temporary cover, or other suitable guard, and see that danger signals or red lights are displayed in a location conspicuous to the traffic until permanent covers are in place or the excavations are filled.

581. Testing for Gas

Do not enter manholes until you have assured yourself that the manholes are free from dangerous gases, as indicated by approved safety lamps, by ventilation, or by other adequate methods.

When work is being carried on in manholes for any length of time where gas collects, suitable ventilation shall be provided or tests with the safety device should be repeated at regular intervals to make certain that gas is not accumulating in the manhole in dangerous quantities.

582. Watchman on Surface at Manholes

Do not enter manholes unless a man is stationed at the surface.

Do not leave a manhole unwatched until all workmen are out.

583. Avoiding Flames

Do not smoke in manholes, and avoid as far as practicable open flames or torches in or near manholes.

If it is necessary to illuminate a manhole, electric lights only should be used. When doing this, it should be known that the leads, sockets, and connections are well insulated and in good condition in order to avoid the possibility of a spark. Special attention should be paid to the sparking of any motors used for ventilating purposes.

Avoid sparks in handling live parts or cable sheaths, and avoid igniting the flux in soldering and wiping joints. In using hot paraffin see that it does not reach a temperature at which it will ignite.

In central office cable vaults tests shall be made for the presence of gas before using exposed flames, and such flames shall not be used in vaults where gas collects.

584. Pulling Cables

When pulling in cables, make sure that the gear cannot slip so as to injure workmen. Avoid the danger of having the hands drawn into the tackle by the pulling line.

585. Reporting Dangerous Conditions

Promptly report to your immediate superior any dangerous condition of your own or other utilities, whether

observed in underground or overhead construction. Particularly report insanitary conditions, gas, or missing cable tags in manholes and abnormally sagging wires or broken supports in overhead construction.

THE NEW WAR TRUCK DESIGN

THE first heavy-duty war trucks the Quartermaster's Department has been designing were assembled and started recently at Lima, Ohio, and in Rochester, N. Y. Both are the Class B truck designed for three-ton load, with capacity for five tons. The assembling as well as the designing of these trucks sets a new record in American production.

Early tests of the engine showed 58 horsepower at 1350 revolutions per minute, and the engine torque curve is better than anticipated. It is now assured that the United States heavy-duty war truck is one of the greatest engineering successes of the war, and that it is destined to revolutionize army truck work, so far as operation and maintenance are concerned, and that the truck will play a large part in affecting truck design in commercial circles.

The War Department and the members of the Society of Automotive Engineers coöperating in the design are convinced that the truck is right. Orders for 10,000 parts for the truck have already been placed, these orders including engines, axles, and other parts.

The maker assembling the first truck states the total weight of the chassis without body is 8500 pounds, which, with a 1600-pound body, will bring the total up to about 10,000 pounds. The engine weighs 1012 pounds, the rear axle weighs 1592 pounds with hubs and brake-drums, the front axle with hubs 352 pounds, the transmission 233 pounds, the clutch and case 103 pounds, the frame without castings 653 pounds, the front springs 148 pounds, the rear springs 544 pounds. With different makers these weights vary from 40 to 50 pounds for the engine, with smaller variations for the other parts.

There were four major divisions of the engineering work: the engine, the transmission, the axles, and the other chassis parts. Each was manned by a corps of engineers. Three, four, and in some cases five, different companies were represented in the work on one unit, and it was necessary for the engineers to sink all personal pride and contribute the very best known to the art. Each unit represents a composite of the best features contributed, rather than the work of any one individual.

So well have all of the engineers coöperated that the schedule set for the completion of the different truck units, as well as of the completed truck, has been lived up to and generally improved upon. The spirit that has made possible the thousands of standards developed by the Society of Automotive Engineers has arisen with patriotic impulse and within little more than a month has evolved one of the most effective transportation units for the conduct of war.

INDUSTRIAL RESEARCH AND ITS RELATION TO UNIVERSITY AND GOVERNMENTAL RESEARCH*

BY C. E. SKINNER

RESEARCH has been defined as "diligent protracted investigation, especially for the purpose of adding to human knowledge." If we accept this definition, we find that it covers an extremely wide field of activities. It applies equally well to the work of the pure scientist, whose primary aim is to extend our knowledge to the remotest bounds of the universe, and to the work of the industrial chemist, who by careful, painstaking analyses maps out the limits of impurities which may be allowed in a manufacturing process. Between these extremes lie possibilities for research in every imaginable field, with pure and applied science so closely interlinked that it is impossible to say where the one ends and the other begins.

That there are possibilities of adding to human knowledge in innumerable ways is evidenced by the status of research to-day. Never before were there so many interested in research in all its branches; never before were there so many forces at work to promote research. Changing economic conditions, even before the war now in progress, made it necessary that research be carried on in almost every field of endeavor. The war has emphasized this necessity many-fold. Many industrial corporations which were not provided with research facilities heretofore are making such provision, and many of those having such facilities are making considerable additions, both for increased amounts and for an increased variety of research. Research departments and scholarships are being provided for in universities and colleges. Commercial research laboratories are being promoted to serve groups of industries where individually they cannot economically provide their own facilities. Scientific and engineering organizations are appointing research committees, and research organizations, such as the National Research Council, are being formed. We have research provided for by private gifts and by governmental grants. The Federal Government is constantly increasing its research facilities in its various departments, such as the Bureau of Standards, the Bureau of Mines, the Forest Products Laboratory, the Agricultural Experimental Stations, etc. This movement is not only national; it is international. Commissions from abroad have studied research conditions in the United States, and the United States have sent men to our Allies to study their progress in research in connection with the war. For the immediate present, progress in pure scientific research is per-

haps much less than prior to the war, but nevertheless the status of research to-day is a condition of great activity. The slowing up of pure scientific research at this time is due to the fact that the workers the world over are in a very large measure engaged either in actual warfare or in research in connection with problems arising thru the war. Fortunately for the future, many of the results of these war investigations will be of great value in connection with the peaceful pursuits to come after the war.

For the purpose of this discussion, research may be conveniently divided into three—possibly four—general classes; this division depending upon the agencies involved and the purposes for which the work is done. These are university research, industrial research, and governmental research—and possibly philanthropic research. The first includes the pure scientific research, which naturally finds its home in the university, and all other research done there for the purpose of training men. The second includes all that done by industrial concerns or for them with the purpose of advancing industry. The third includes all that carried on by the Federal or the State governments for the purpose of benefiting the people as a whole. Philanthropic research differs from governmental only in the fact that its funds are provided by individuals, instead of by the government, as, for example, the work of the Rockefeller Foundation. No sharp dividing lines can be drawn between these classes. They all have much in common. All should be scientific. Much industrial research is philanthropic, and many times university research leads to industrial progress. Governmental research is for the purpose of serving the whole people, and it therefore does much for education and for industry and certainly could be classed as philanthropic. It is just as difficult, therefore, sharply to maintain these classifications as it is to maintain a clear-cut distinction between pure and applied science.

The primary function of the university in research should be the training of research men. If the conditions outlined in the introduction of this paper are accepted, then it is evident that men with the broadest and best training possible are going to be required in ever-increasing numbers for every possible phase of the work. It is self-evident that the fundamental training of these men must be gotten in the university, and universities should be equipped to turn out research men just as they are now equipped to turn out men with academic and engineering degrees. It is to the university we must look

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for the broad fundamental training so necessary in research. These trained men will, in accordance with their training and their fitness, find their places in pure scientific research, in industrial research, in governmental research, and in teaching positions where more and more research men are to be trained. In this connection it is rather a sad commentary that the university has not been able to make its teaching positions more attractive by providing compensation more in line with that obtainable in other lines. While writing this paper, its author received letters of inquiry for several men for teaching positions—some in connection with research—with specifications which could be met only by men of considerable experience. The compensation named was very much less than that which meeting the same specifications could command in other lines. While it is generally understood, at least by those outside the teaching profession, that it has many compensations, such as short hours and long vacations, the average salary is certainly not one of these special attractions. We have splendid endowments for buildings and sometimes for equipment, but we have practically no endowment for men of genius who might make notable progress in pure research and at the same time serve as teachers and examples for the training of men for the whole field. If it takes a genius to recognize a genius yet undeveloped and properly to stimulate and direct that genius, how necessary it is that we place men of genius at the head of the research departments of our universities! A few are already so equipped, but this is a plea for a larger and a more definite program of research training and the development of that judgment which will be able to direct these trained men to the line of work for which they are best suited.

In training research men, the university will naturally become the custodian and the promoter of pure scientific research. Properly equipped and properly manned, here as nowhere else can go on with ever-increasing acceleration that wonderful work leading to the discovery of new elements, new laws, and new phenomena. It is here that studies can be made of phenomena which are of absorbing interest, but which apparently have no commercial value whatever. It is here that we must look for studies of such things as the photoelectric effect, the penetrating power of alpha, beta, and gamma rays, the character of the emanations of radium, the study of vortex action, and a thousand other studies—all of which have value in advancing our knowledge of the unknown. All have value in the training of men, and it may not be too much to say that all will ultimately be of value in advancing the well-being of the human race. Contact with pure scientific research of this kind is of the utmost value to the research worker in whatever field, if for no other reason than the stimulus it gives his imagination, and a research worker without imagination is sure to be a failure.

Industrial research problems cannot, as a rule, be given over to university research departments for solution. There are many reasons for this—the patent situa-

tion being one of the prominent ones. So long as industry depends so much upon patents or upon secret processes for the protection of its business it must carry on its vital research within its own laboratories and under its own control. Many industrial problems are also so closely related to the work daily being performed in producing the particular commodity that any research in connection therewith must be done on the ground and by men familiar with all phases of the problem.

There are, however, many problems which could be turned over to university research laboratories for solution, and these would be very valuable for the training of men for the industry. These are problems having to do with such things as methods of measurement or fundamental laws, such as the laws of heat transferences or the laws of hysteresis.

There should be much closer coöperation between the university and industrial research. Industry should recognize that it must depend primarily upon the universities for its trained research men and coöperate to the fullest possible extent, to the end that properly trained men be turned out. Pure scientific research should be recognized as the legitimate field of work of the university. The application of science to industry should be recognized as the field of the industrial research organization, and it should be realized that no sharp dividing line can be drawn between the two. The university should do research primarily to train men, and the industry to ensure dividends to its stockholders.

Governmental differs from industrial research mainly in the fact that it is financed and directed by the government, and its results should therefore be directly available to all the people. It has many and varied fields, such as those relating to the development and conservation of our resources, the national defense, and the establishment of standards of weights and measures. Much governmental research is undertaken for the benefit of industry in general, and its methods and equipment are necessarily much the same as those used in connection with industrial research. Like industrial research, it must look to the university for the training of its men. As in industry the present war has brought very greatly increased demands on our governmental research departments and has also shown the desirability of increased coöperation between all the forces having to do with research, both at home and abroad. Here again it is difficult to draw a sharp dividing line between the work to be undertaken by the Federal or the State government and that which should be left to industry or to the university. It is safe to say, however, that as in other lines research carried on by the government will increase in amount and in the kinds of work undertaken, and that, further, there will be increased coöperation with other agencies carrying on research.

While philanthropic research has been mentioned as a possible class, its function and relation to the other classes mentioned are so obvious that it will not be further discussed here.

Industrial research has been described as having for its primary function the securing of dividends to the industry. Fortunately for those engaged in it, its ideals can be just as high as those of pure scientific research, for its work usually results in direct and lasting benefits to mankind. This is certainly true of those researches which have given us commercial wireless telegraphy, transcontinental telephony, half-watt incandescent lamps, giant turbo-generators, modern tool steel, and a host of other things.

No single description will apply to the rise of research departments in different industries. In the older industries, the early work was usually carried on by more or less "rule of thumb methods," with a certain amount of experimentation directly on the product. Later, test laboratories were established, and finally these were either combined into a research department or a separate and distinct research department was formed to take care of the necessary research work. In many of the newer industries, the foundation on which the industry has been built is the result of research, and in such cases research work is almost always continuously maintained thruout the life of the industry.

The research division may be so organized that it can be a leader in the development of new things and at the same time keep in closest possible touch with their application and use. Problems for solution come to it from every possible direction, and not the least fertile source of theoretical problems is the grist of troubles from the daily routine work in the factory. We believe that the research division should both lead and follow the practical end of the work. There should be work going on which has for its object the securing of information or the perfecting of devices which will be required in future years. At the same time, old processes should be improved, old devices should be reviewed, and new treatments should be provided for old material. Research should lead, should follow, and should parallel engineering and factory work. Many times the results of researches cannot be taken advantage of at once, and there should be a constant accumulation of information available when it is needed. No research can ever be considered as complete. Each new advance in contemporary lines, whether new instruments, new materials, new methods, new applications, or new laws, will make further advances possible, tho not always profitable.

What of the future of industrial research? What lines will be profitable? Should there be greater centralization and greater coöperation between industrial, governmental, and university research? The answers to these questions might well be given with counter-questions. What industrial subject is so far advanced that further advances are impossible? If coöperation is profitable in a single corporation, why should it not be profitable between greater forces? It should be evident, from what has gone before, that the writer believes implicitly in a constantly increasing field for research in every industry. If we can show advances in any material or process or device by proper research, why should not every industry profit by research? It is not expected that every individual study will be profitable nor that every successful result can be at once applied, but careful, painstaking, and persistent research should benefit any industry. It is expected, of course, that the research undertaken will have a direct bearing on the particular industry and not be a study of some unrelated subject. It would hardly be profitable for the steel industry to make an elaborate study of the life history of the yeast plant, but the progress in alloy steels has so profoundly changed many industries in the last few years that further research in this line will surely be of value.

It is probable that more and more industries will establish research departments or enlarge their research work (often carried on under some other name), and that these will in a large measure for the present work independently of each other. We must expect competition in this line as well as in other industrial lines. We may confidently predict, however, that we will have an increasingly better general coöperation of all research forces and such agencies as the National Research Council, which bring together for a common purpose men engaged in every phase of research should have a profound influence on bringing about this coöperation. If such organizations are a benefit in times of national stress and need, surely they can be of similar value in times of peace. The university, the government, and industry each has its distinctive field and each needs the coöperation of the others, and only when we secure complete coöperation among all these forces can we make our best advances as an industrial people.

INDUSTRIAL RESEARCH AND THE COLLEGES*

BY A. E. KENNELLY

IN any general discussion on the influence of research in the development of electrical industries, the share of the college in this influence deserves to be formulated and defined. The more clearly we can realize the ways in which the colleges can assist in this work, and the more closely we can agree upon the methods by which this assistance can be rendered, the more likely we are to be able to bring about the result desired. In what follows, certain propositions are ventured, in the hope of eliciting discussion, and of thereby reaching a consensus of opinion.

To begin with, it will probably be admitted that industrial research is scientific investigation directed economically toward improvements in production.

The introduction of industrial research in the recent and more restricted sense has come about partly materially thru the opportunity provided by large-scale mechanical or chemical processes, and partly psychologically thru the change in the general attitude of mind toward applied science. Formerly, there was an attitude of distrust toward scientific training in industry. Now it is coming to be realized that in all industry applied science can be made to pay. In fact, it is coming into general apprehension that sooner or later any industry will be outdistanced competitively unless maintained not only by eternal vigilance but also by eternal scientific study.

The part of the colleges has been and is to train young men to learn a business studiously and to carry it on systematically. In the colonial days the colleges educated men almost exclusively for the professions. To-day the men educated in the colleges enter general business in as great numbers as they enter the professions.

The non-technical scientific departments of the colleges and universities include such fundamental subjects as mathematics, physics, and chemistry. The duties of these departments of so-called pure-science (*i.e.*, science contemplated apart from applications) are two-fold, namely:

(a) Teaching, by carrying on instruction of the students in those sciences.

(b) Learning, by carrying on researches in those sciences.

The teaching and the learning have to be carried on interdependently and perpetually.

It is probably undesirable that the pure-science departments of the colleges and universities should continuously

undertake industrial research. There is nothing in their work to prevent their teachers or students from undertaking such research. Many of their staffs are excellently qualified for conducting industrial research; but there is so much other important work to be done, which these departments are alone able to do. In all times, the progress of the sciences has been largely left to the college teachers of those sciences. Physics and chemistry are subdivided into so many branches that no one man can do justice by his efforts to more than a very small number of studies. There is a limitless field of undreamed-of knowledge everywhere along these various lines. The expenses of modern scientific laboratories are so great that few private individuals can expect to conduct researches in pure science, and the instructing staffs in the college laboratories have special facilities for experimental work. The bulk of new scientific material, on which industries may ultimately depend, has to be worked out and discovered in the pure-science laboratories of the world. Again, mathematics is a science covering a range of knowledge, thought, and inquiry so vast that no one mind can compass it, and yet its knowledge is woefully backward and deficient, even for purely utilitarian purposes; so that there are immense fields to be developed, even on the unlikely hypothesis that no new general discoveries will be forthcoming. Of the indefinitely great number of mathematical functions that may be mentally reviewed, only a few dozens have yet been tabulated and arranged for practical use. The progress of knowledge in mathematics is far less restricted to the college faculties than the progress of subjects like physics or chemistry; because the necessary plant is so inexpensive—white paper, black pencil, and gray matter—yet even here the influence of the college atmosphere for mutual teaching and learning is relatively so productive that a large share of the world's mathematical pioneer work emanates from the colleges.

While, therefore, under extraordinary circumstances, such as those due to the present World-German war, the pure-science departments may advantageously take up industrial research, yet, as a general rule, the best contribution of those departments to industry is by restricting their attention to pure science.

When we come to the engineering and technical colleges, or to corresponding university departments, the opportunities for their sharing in industrial research are greater. In the first place, they train men directly for work in applied science, and, in the second place, their contact with manufacturing industries is greater. By

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comparison with the pure-science departments, their field of activity is, on the one hand, intellectually narrower; but, on the other hand, they come into closer relations with the needs and problems of industries. The applied-science college laboratory staffs are very frequently occupied on engineering and constructive problems of the industrial world. Such activities are valuable, both to the colleges and to the industries, provided that the amount of industrial research work undertaken does not swamp the regular teaching. There are various ways in which the technical colleges can assist in industrial research, and among them the following:

1. Training industrial-research investigators to go out into the industries.
2. The taking up of particular industrial-research problems by particular members of the laboratory staffs, under individual private agreement with industrial concerns, the work being carried on in the college laboratories.
3. The same as in 2, but with the work carried on in the workshops of the industrial concerns instead of in the college laboratories.
4. By the industries formulating their problems directly to the college as a corporation, and entering into an agreement for the maintenance of research work, in the college laboratories or elsewhere, toward the solution of those problems.

The only essential difference between scientific researches carried on for an industry, and general scientific researches carried on without reference to any industry, is that the former are expected to bring in results of economic value, and must therefore be safeguarded by secrecy, while the latter, being expected to bring in results of scientific and engineering value only, naturally demand publication so far as they are successful. It is manifest that no industry could afford to undertake research unless it expected the results to pay a profit on the expense, and such profits would be jeopardized if the successful results were communicated to competitors. The watchword of industrial research is therefore loyalty to the industry which makes the venture in investigative effort, and this entails watchful protection as to the secrecy of the investigation and its results.

So far as the large industries are concerned, they install their own experimental laboratories and employ their own experimental investigators. It is natural and proper for them to protect the results of their inventive and experimental efforts either by patents or by concealment, as may best suit the industrial need. The colleges can best serve these auto-research concerns by supplying them with well-trained graduates. The difficulties lie in the paths of the smaller industrial concerns, which desire to make progress by scientific effort and systematic study, but which cannot afford the expense of a special private research department. These younger industries must have recourse either to the services of a consulting specialist of the researcher type or to the services of some specialist college laboratories.

The call of the younger industries on the technical colleges for help is one which the colleges naturally desire

to meet, so far as they can do so without disrupting their regular work of teaching and learning. On the other hand, the task is rendered difficult by the need for secrecy, and for the discrimination in dealings which that secrecy may involve. The whole atmosphere of any healthy college is one of intellectual freedom. The ideas and knowledge of any individual in the college community are placed at the academic disposition of all of the rest who may be inquisitively inclined. A recognized exclusive monopoly of information or knowledge must interfere with the best qualities of any institution of learning. Consequently, the maintenance of any considerable amount of industrial research in a college becomes a burden and a difficulty. For this reason, either method 3 or a combination of methods 3 and 4 is perhaps the best for a technical college to follow, when a considerable amount of technical research is desired to be undertaken for those industrial concerns which are not in a position to maintain their own research laboratories.

In the long run, therefore, it seems most desirable that the technical colleges should always carry on general researches in their laboratories, of such a nature as may advance applied science, stimulate careful observation on the part of students, contribute to the published fund of available technical information, supply new knowledge to the teaching staffs, and train students for entering industrial research. To this end, research fellowships and research endowments are of the greatest aid both to the colleges and to the industries. A limited amount of industrial research work may also be advantageously carried on in the college laboratories, along with the general research work. As with the growth of new industries more and more demand for such industrial research comes to the colleges, the desirability increases of dealing with it in a systematic way thru the college as a corporate body, by maintaining, in the workshops of the industrial concerns, special assistants under the direction of specialists on the teaching staff. In this way, perhaps, the most effective service may be given by the technical colleges to the junior industries, with the maximum of economy. It may not be too much to expect that, as time goes on, the junior industries may lean more and more upon the technical help of the colleges, without having to enter into any mutual agreement or combination, in order to avail themselves of such aid.

An ideal international system would be one in which the pure-science colleges should lay the foundations of future industries by enlarging and disseminating the world's knowledge of the basic scientific principles; the technical colleges should do the same for applied science, while at the same time taking a share in the economic applications of science to industry. The industries themselves should undertake their own researches, under the guidance of qualified research specialists. Vocational schools would train industrial foremen in the elements of the same principles of science, art, technique, economy, thrift, and hard work, as applied to those particular industries in which each nation, is, by its peculiar circumstances, specially adapted to excel.

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CONTENTS OF THIS ISSUE

	PAGE		PAGE
Engineering and Construction Features of Cantonments	553	Schedule of Meetings of The Engineers' Club and Affiliated Societies, December, 1917	584
By MAJOR RICHARD C. MARSHALL, JR.		Secretary's Notices	585
General Utilization of Pulverized Coal	556	The Engineers' Club is Pledged to Support the United States Food Administration	587
By H. G. BARNHURST		Committee on Membership	588
The Relation of the Banker to Industrial Chemistry	562	D. ROBERT YARNALL, Chairman	
By G. A. O'REILLY		Positions Open, Positions Wanted, etc.	589
The Utilization of Nitre Cake	565	Junior Section	590
By W. W. RHODES		Committee on National Service	591
Two Conventions	569	GUILLIAEM AERTSEN, Chairman	
By JAMES F. MCCRUDDEN		Illuminating Engineering Society	594
The Much-Abused Term "Mass" in Engineering Calculations	571	Society of Automotive Engineers	594
By CARL HERING		American Institute of Electrical Engineers	595
Efficiency Work as Applied to Clerical Forces	574	Philadelphia Safety Council	596
By JEAN G. ALLEN		American Society of Heating and Ventilating Engineers	596
The Influence of the War on Submarine Policy	576	Technology Club of Philadelphia	597
By MARLEY F. HAY		Worcester Tech Club	598
Officers, Directors, Standing and Special Committees of Engineers' Club	581	Index to Advertisers	ix
Committee on Papers	582		
LEWIS H. KENNEY, Chairman			
Calendar of Regular Meetings of The Engineers' Club and Affiliated Societies, 1917-1918	583		

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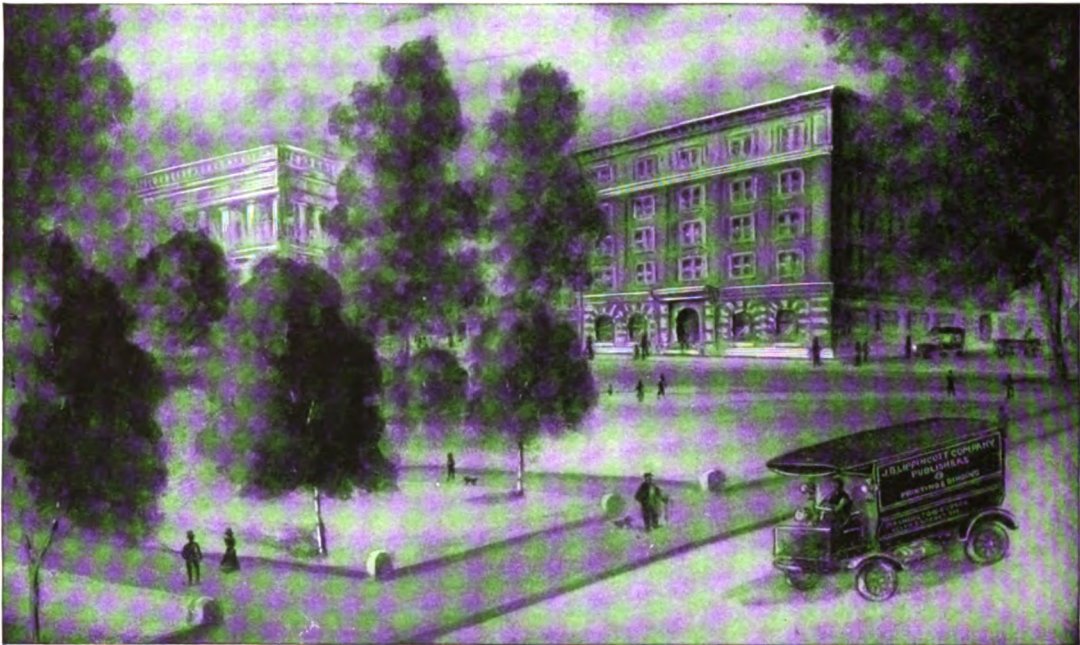
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ENGINEERING AND CONSTRUCTION FEATURES OF CANTONMENTS*

By MAJOR RICHARD C. MARSHALL, Jr.

QUARTERMASTER CORPS, U. S. A.
ASSISTANT TO OFFICER-IN-CHARGE OF CANTONMENT CONSTRUCTION

ON April 6, 1917, when the Congress of the United States was forced to declare that a state of war existed with the Imperial German Government, it found this country both peace-loving and peace-



Harris & Ewing

MAJOR RICHARD C. MARSHALL, JR.

pursuing. It would not consent to think of war, or the preparations for war in the true sense, or in the sense that the few military men of the nation had been trying to impress upon the country. Most potential of all the world in possibilities, this country was least powerful in its military forces, either for offense or defense. The war in Europe had been raging for more than three years and we had all hoped to keep out of it. In spite of this, there

were very few preparations being made here. The battle lines in Europe extended to hundreds of miles, the European armies to millions of men, guns of all ranges to thousands, ammunition to thousands of tons; yet our preparation was only that induced thru the necessities of those countries which were at war.

We have become accustomed to large figures, and in the building of the cantonments everything ran into tremendously high figures. The Quartermaster General's office has always been charged with the construction work for the army. The division that had

that work in immediate charge was the Construction and Repair Division of the Quartermaster General's Office, and at the outbreak of the war it was composed of three officers, a force of twenty clerks and stenographers, and twenty engineers, architects, and draftsmen. This force kept the regular army posts fully repaired and did what construction work was necessary from time to time to house the army. It now faced the huge task of building the cantonments. It was not known what the task would be, as no plans could be formulated until it was known whether the conscription law would become a fact or not.

On May 18 last Congress passed the conscription law, and it was not until that date that plans could really be formulated in any definite shape. In the meantime the Council of National Defense, thru the Munitions Board, had formed a Sub-committee which was known as the Sub-committee on Emergency Engineering and Construction. This committee, in consultation with the Quartermaster General's office, looked toward laying out the plans for this purpose. When the amounts of the needed supplies were counted off, it did not seem possible to mobilize them to put them into the various buildings. At that time it was a mooted question whether there would be sixteen cantonments with a capacity of 650,000 men or thirty-two cantonments with a capacity of 1,200,000 men. If the latter, the supplies necessary would have been about double what would be required by the former. At that time no sites had been selected on which to locate any of the buildings, so that the problem was made a most difficult one.

After the conscription law had become a fact, it was determined by the General Staff that the cantonments should be constructed in sixteen different places, located as far as possible within the draft areas, and that sixteen camps would be constructed for the National Guard located in the South and West, where climatic conditions would permit training all year round, and where camping conditions would be better than in the North. The same authority also determined that the

* Address presented at Joint Meeting of the Engineers' Club and the Worcester Tech Club, Witherspoon Hall, November 20, 1917.

several department commanders should select the sites for the cantonments, and that the Cantonment Division should be created for the purpose of constructing the same; this Cantonment Division to be an extension of the division of the Quartermaster General's office which had before been known as the Construction and Repair Division.

The engineering, the purchasing, the mobilizing of materials, and the securing of 60,000 laborers were problems that seemed insurmountable, but with the aid of the Sub-committee on Emergency Engineering Construction the men required for the various purposes were obtained from the localities near the cantonments. It was the original conception that 1200 acres of ground would be needed for the various build-

these cantonments the experience of the army on the Mexican border served to guide. There it was found that the life of a tent was from three to four months, and that the cost of housing men in tents was approximately \$12.50 per man per tent; that the replacement of a minimum of three tents a year and the cost of housing per year per man was \$36.50, without any reference to the cost of water supply and other necessities in the make-up of a camp. This consideration alone was sufficient to have abandoned the idea of tentage; but it was a fact that it was impossible to obtain the tentage. Indeed, it had barely been possible to secure the tentage for the National Guard troops now in camp. The National Army is supplied now with little or no tentage. There are some few



CAMP SHERMAN

ings. To secure 1200 acres of ground, put them into building shape, and do the preliminary engineering seemed impossible in the allotted time.

The Cantonment Division was organized in the early part of June, and it was expected that by September 1 a sufficient number of buildings would be ready to house the first increment of the draft. Less than three months were given for the selection of sites, the development of the water supply, the determination of the sewage disposal, the construction of railroad facilities, obtaining the necessary electrical power and all other public service utilities that go to make up a city. Many of the sites were at some distance from the nearest railroad, and in some instances six miles of railroad had to be built to reach the site selected. Where this was the case the transportation facilities were such that the getting of the first material on the ground had to be done entirely by trucks over country roads with the usual accompanying difficulties.

The several Boards appointed to select the sites, having made local arrangements for the rental of the same, telegraphed the selections to Washington, giving the approximate locations. Engineering parties were immediately sent out to make topographical surveys, and also engineers to examine the water supply and to determine the sewage disposal. The water supply was the prime consideration of the Boards selecting the sites, and in every case an engineer selected for the purpose advised in that one particular.

In considering the buildings to be constructed for

tents which were there originally with the guard during the construction period. During the construction period of each and every cantonment a guard of one battalion was supplied, for the purpose of protecting the Government property and for fire protection. In addition to this guard, the Fire Underwriters detailed an engineer to each cantonment, so that fire protection during the period of construction was carried on under the best auspices possible, and during that period of construction there have been some 235 fires, with a total loss of only about \$2000 in all for the sixteen cantonments.

Lumber was the principal item in construction. The amount of lumber used was approximately 39,000 carloads, converted into board feet, making approximately 40,000,000 board feet per cantonment, or 640,000,000 board feet for all the cantonments. This is exclusive of the National Guard camps. If the lumber used was all in 2-by-4-foot pieces, placed end to end, these pieces would reach eight times around the earth. If cut into one-inch planks, laid flat, it would cover an area of $27\frac{1}{2}$ square miles.

Obtaining the lumber was a difficult problem, as no local lumber markets could be used to advantage, the enormous demand upon each being too great. The Lumber Sub-committee of the Munitions Board materially aided the Cantonment Division by standardizing the lumber sizes with the plans so that the sizes used would be in standard lengths as marketed and that the wastage would be held to a minimum. The amount of

CANTONMENTS: ENGINEERING AND CONSTRUCTION FEATURES

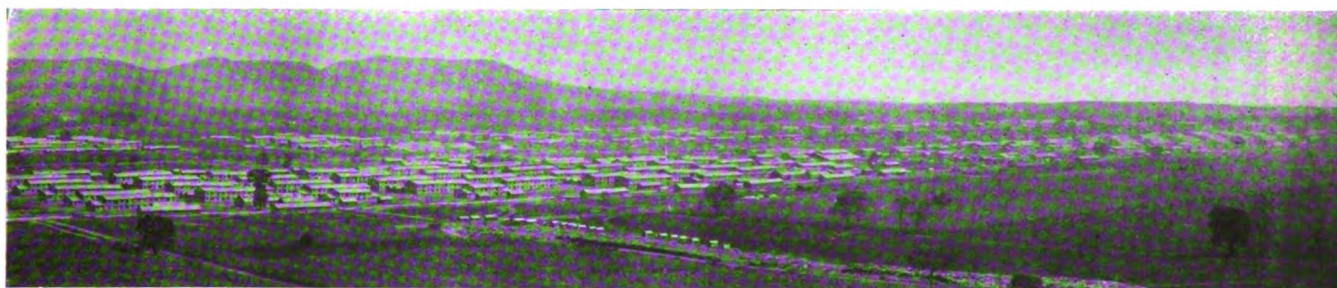
lumber in carloads was just about half the total amount of materials, the latter being some 80,000 carloads. Moving 80,000 cars in three months to the different points to arrive at the proper time taxed the railroad facilities to the utmost.

In making the lay-out for the cantonments city planners were in consultation with architects and engineers, and the final lay-out was an adaptation of the regimental units to city blocks, each cantonment being a city of from 40,000 to 45,000 population.

The typical lay-out was applied to each particular site, and, while it was impracticable at any place absolutely to follow the typical plan, in many places it was closely approximated. In other places the type was

The popular idea is that on this contract all contractors receive ten per cent. above the cost of the work. As a matter of fact, most of them are receiving three per cent. approximately. The cost = plus is scaled, and the maximum amount any contractor can receive is \$250,000. This \$250,000 is to cover all overhead expenses. The cost of the cantonments has been approximately \$120,000,000.

Similarly, in drawing up contracts for engineering fees, there were three forms used for engineering services. One—and the one least used—was $\frac{3}{4}$ of 1 per cent. for all engineering services. This contemplated an engineering concern with a large and well-developed organization that could care for every form of engi-



CHILLICOTHE, OHIO

not followed to any extent, except to preserve the entity of the block. The buildings were designed for the units of the army as they formerly existed, being 150 men per company. The barrack building was designed for 150 men, but when about half finished, upon the recommendation of General Pershing, the whole organization of the army was changed, and the unit of the company became 250 men. The final plan adopted was a building to house 66 men, using a mess-hall and lavatory in addition, so that four of these barrack buildings would house one standard unit, and also could be adapted to other units, larger and smaller.

The question of heating at the cantonments presented a very serious problem. Steam heating was admittedly the best, so far as fire risk was concerned, as it would allow the distribution of heat to the best advantage; but steam heating could not be had. As it was impossible to obtain necessary piping, radiation, and boiler capacity for so many cantonments, the steam heating was installed at only four of them and is only now being completed. The barracks are heated by room heaters, which are hot-air furnaces set up in the middle of the room. For heating purposes there have been used, all told, some 40,000 stoves, about 60,000 horsepower in boiler capacity.

Much has been said about the form of contract used in connection with letting the work at these cantonments. The cost = plus form of contract was adopted by the War Department after considerable deliberation.

neering to be met. Only in places where we had very difficult problems was this form of contract used. The other two forms were flat amount for specific services, and these are the forms of contracts generally used thruout in the work. The cost of material has been kept to the lowest the market has permitted at this time.

Statements have been made about the extravagance experienced, and much has been said about waste. There may have been some profiteering, but if there has been any such, the blame should not be laid upon Government officials who have exerted their utmost to carry out their mission to have the buildings ready for occupancy on time, but the blame should be laid where it is due, and that is on the profiteers.

We are in this war now, and we are in it to win. The question of finances should not stand in the way. Many men of education, deep thinkers, and patriotic men have said publicly that the democracy of the world hangs by a hair, and that unless the necessary steps are taken to check Germany in her victorious path, this country will become a subject nation. If that thought can be planted in the minds of persons thruout this country, the question of small profits, or any other question, will sink into insignificance.

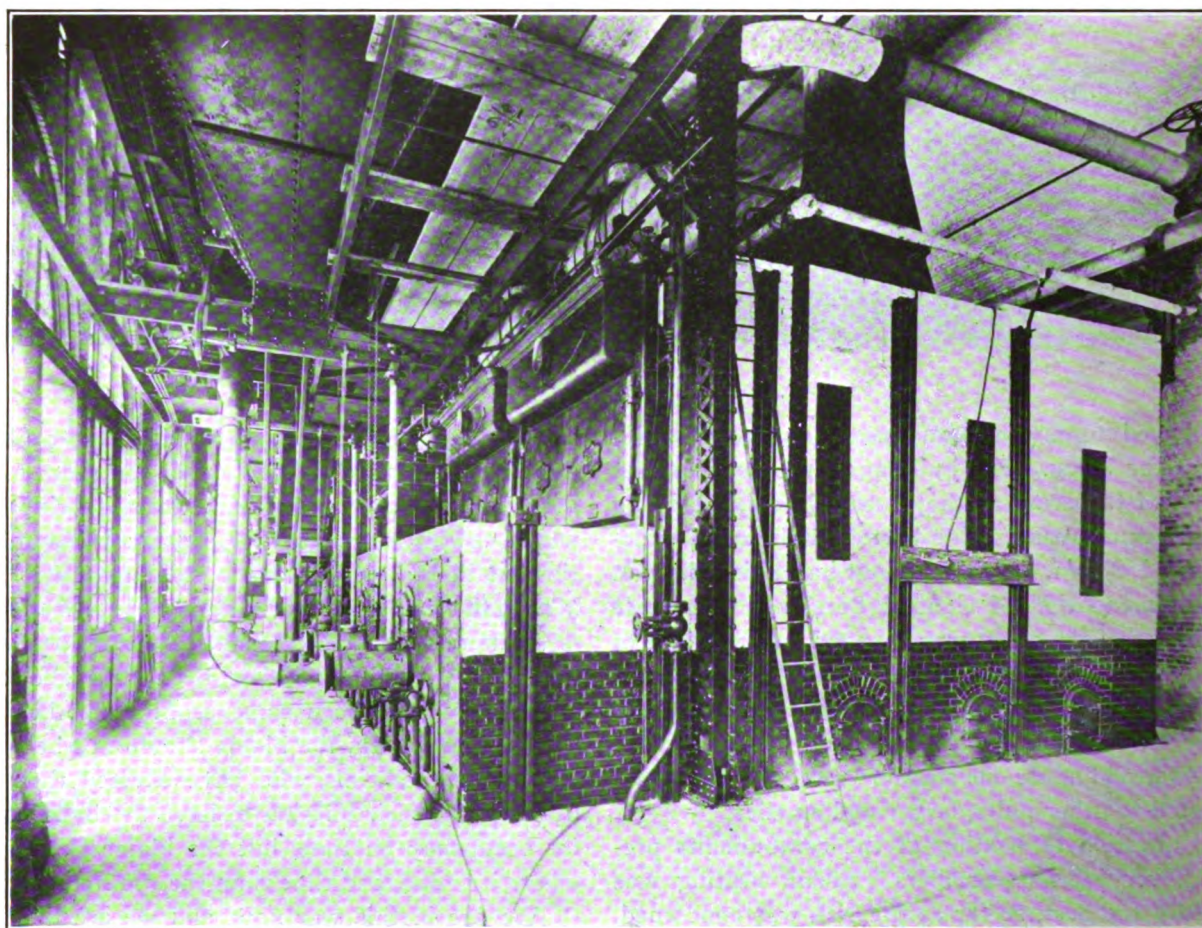
(Slides were exhibited showing typical plans, sites in various stages of transformation, typical buildings for men and services, sewer construction and water-supply, etc., and two motion-picture films showing the construction of the various cantonments and other details.)

GENERAL UTILIZATION OF PULVERIZED COAL*

By H. G. BARNHURST

PULVERIZED coal was first applied successfully for economical reasons in connection with the burning of Portland cement. The growth of the Portland cement industry also had a great bearing on the development and use of pulverized coal, in that, it is in

rels of Portland cement made in this country annually, these figures will give one a reason why pulverizing machines have been so highly developed during the last few years. Fine grinding of the raw material means reduction in the quantity of fuel required and also makes pos-



PULVERIZED COAL APPLIED TO M. K. & T. RY. BOILER AT PARSONS, KANS.

this industry that pulverizing machines were brought to the present high state of development, for in the manufacture of cement not only the coal is pulverized, but for each barrel of cement manufactured weighing 380 pounds there are required about 600 pounds of raw material, such as limestone shale or cement rock, as well as the 380 pounds of clinker produced by the kilns, which must be pulverized in order to make the finished product, so that in the neighborhood of 1100 pounds of raw materials, clinker and coal must be ground to produce one barrel of Portland cement. As there are a hundred million bar-

rels of Portland cement made in this country annually, these figures will give one a reason why pulverizing machines have been so highly developed during the last few years. Fine grinding of the raw material means reduction in the quantity of fuel required and also makes pos-

sible the highest quality of the finished product, so far as the chemical analysis or combination is concerned. Fine grinding of the clinker means increased strength, for the reason that the hydraulically active units in cement are in direct proportion to the percentage of fine or impalpable powder in the finished product.

Somewhere between thirty to fifty million tons of pulverized coal have been used to date in the manufacture of cement alone. The application of this ideal form of fuel has been gradually taken up by engineers connected with other industries, who have speedily recognized its value to such an extent that the steel industry to-day is using in the

* Read by H. R. Collins, of Fuller Engineering Co., at meeting of A. S. H. & V. E., October 11, 1917.

GENERAL UTILIZATION OF PULVERIZED COAL

neighborhood of two million tons of pulverized coal annually in various types of furnaces, such as open-hearth, heating, puddling, soaking pits, continuous heating, reheating, annealing, forging furnaces, and furnaces of practically every description where heat is required, and *is being used successfully*.

A great development is now going on in the application and use of pulverized coal in connection with the copper industry; ore roasting furnaces, reverberatory and copper melting furnaces of all types are now successfully operating with this form of fuel, and between one and two million tons of pulverized coal is used in this industry alone each year.

Another large field in which pulverized coal is commanding attention is in its application to rotary kilns for the desulphurizing and roasting of various grades of ores and also nodulizing flue dust so as to make available products heretofore rather expensive to recover. In one installation ore is now being treated at the rate of 800 to 1000 tons daily, requiring from 250 to 300 pounds of coal per ton of ore desulphurized and nodulized.

In another large installation ores carrying as high as 40 per cent. *moisture* and of rather a soft nature are being successfully handled, requiring from 400 to 500 pounds of pulverized coal per ton of ore nodulized.

Pulverized coal is being successfully used to-day in the burning of lime in rotary kilns for making oxide of

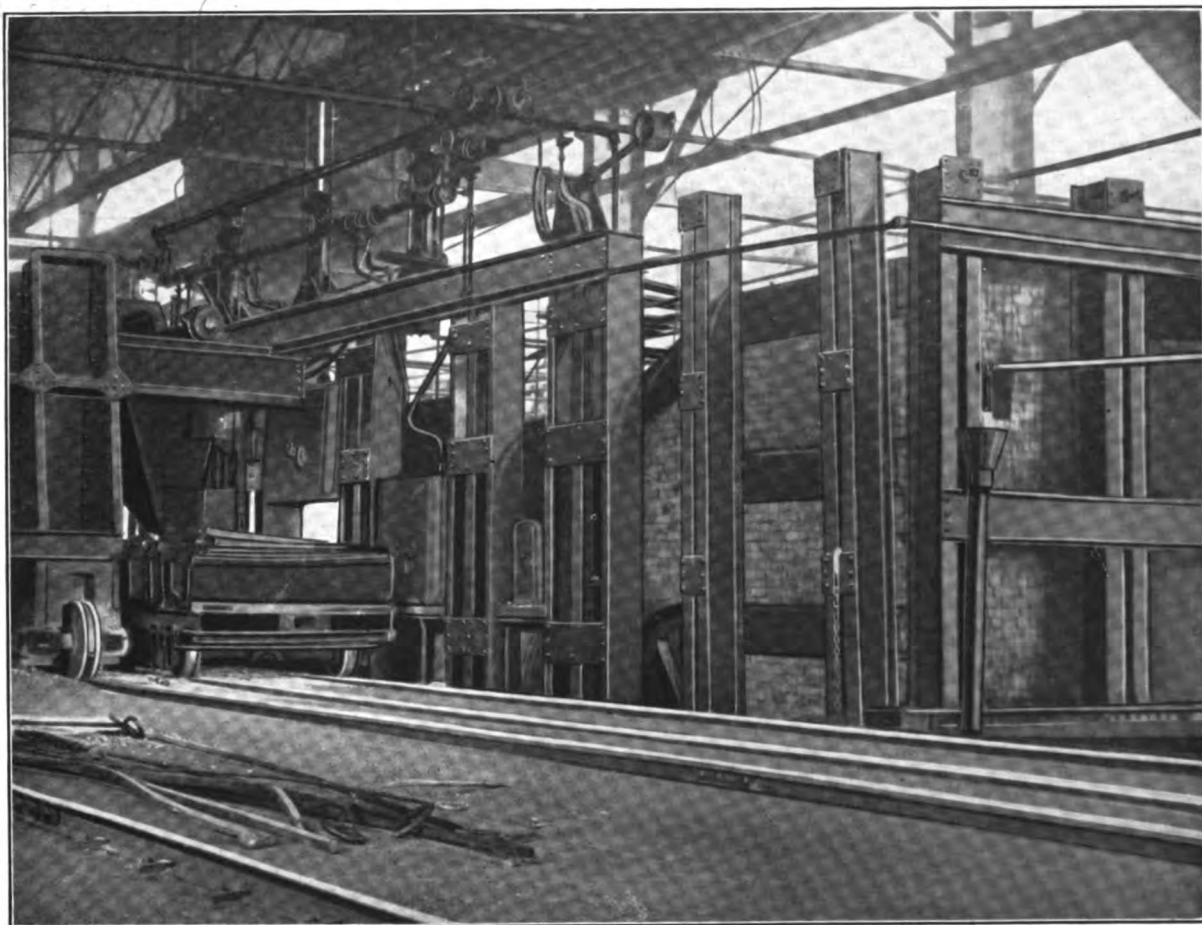
lime for use in open-hearth furnaces; also for burning dolomite to replace magnesite used for furnace linings. The shortage in the supply of magnesite has been responsible to a certain extent for this development.

A still further and very important development is now going on, which will, when it attains its growth, require more pulverized coal than probably all of the other industries combined, and that is in its application to locomotives, particularly in the West. This application is now being developed.

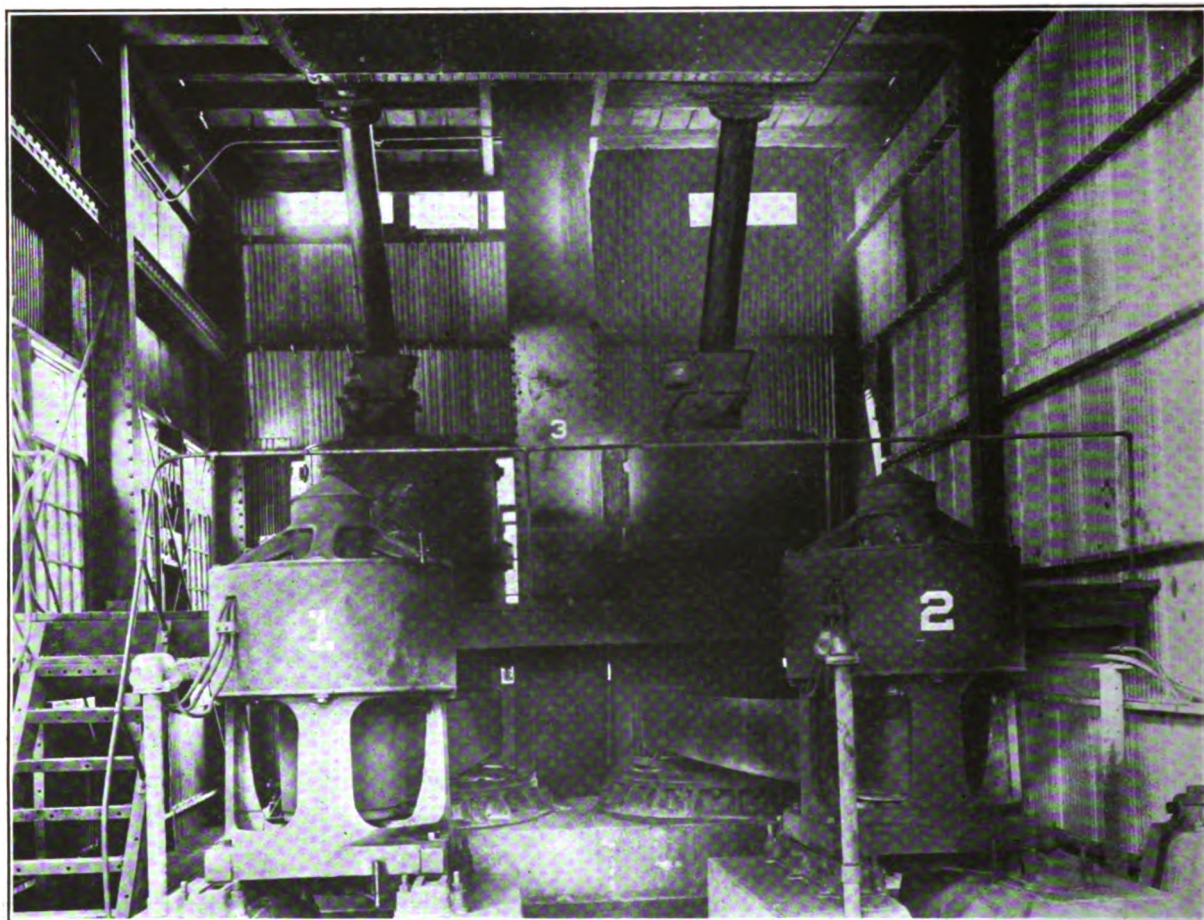
There is still another field in which enormous quantities of this fuel will be used and a field in which we are all concerned, and that is in the generation of power in stationary power-houses.

There are quite a number of installations now in successful operation using in the neighborhood of one hundred to two hundred thousand tons of pulverized coal annually, and the success obtained by these plants has created so much interest and has brought out so strongly the desirability of the use of this fuel for power purposes that to-day there are a number of new installations now being made, and by engineers of national repute.

The peculiar conditions as they exist to-day on account of the war and for other reasons, such as the gradual disappearance of sources of fuel, such as natural gas, and the shortage in supply of crude oils, which have become of too much value to be used for ordinary fuel



CHARGING SIDE OF 50-TON O. H. FURNACE BURNING PULVERIZED COAL



42-INCH FULLER LEHIGH PULVERIZING MILLS IN COAL PLANT AT PARSONS, KANS.

purposes, have compelled those interested to carefully investigate the possibility of the adoption of pulverized coal to replace their present expensive methods of operation and high cost of fuel.

Practically any coal can be burned in pulverized form with a proper furnace and burning equipment. Each application, however, must necessarily be governed by the quality of the fuel available in the district in which it is made. Generally speaking, however, the coals which would give the most satisfactory results would be those in which the ash content would be less than 10 per cent., the volatile averaging between 30 per cent. and 40 per cent. and the fixed carbon between 40 per cent. and 50 per cent. The sulphur content should be low, altho coal with a sulphur content running as high as $4\frac{1}{2}$ per cent. to 5 per cent. is being burned in pulverized form under boilers without any detrimental results. The ash should have a high melting-point. These statements, however, are tentative, as most excellent results have been obtained from all sorts of coals, differing widely from the ideal analysis stated.

It is very apparent that the development in this method of burning coal has brought coals from which heretofore very inefficient results have been obtained within reach of a great many consumers. For instance, from Texas to Edmonton, Alberta, the country is underlaid with various grades of lignites, low-grade mineral coals

with high moisture content and of such a nature that the ash would melt or flow down on the grates, thereby preventing the highest efficiency from being obtained. They are of such a nature that their use in gas producers is not very satisfactory, so that until the development and burning of these coals in pulverized form was an assured success these coals were not used in as large quantities as is now possible.

The largest deposits of lignite and mineral coals appear to be in the Northwest, awaiting future development when proper means are at hand for obtaining the highest possible economy from their combustion, and the location of these large deposits will now be of great value to the districts in which they are located.

Around steel plants there are large quantities of waste fuel, such as coke breeze. This fuel is being used to a certain extent on some forms of grates, with forced draft, but it can be burned in pulverized form under boilers for the generating of power and possibly in the open-hearth furnaces for making steel.

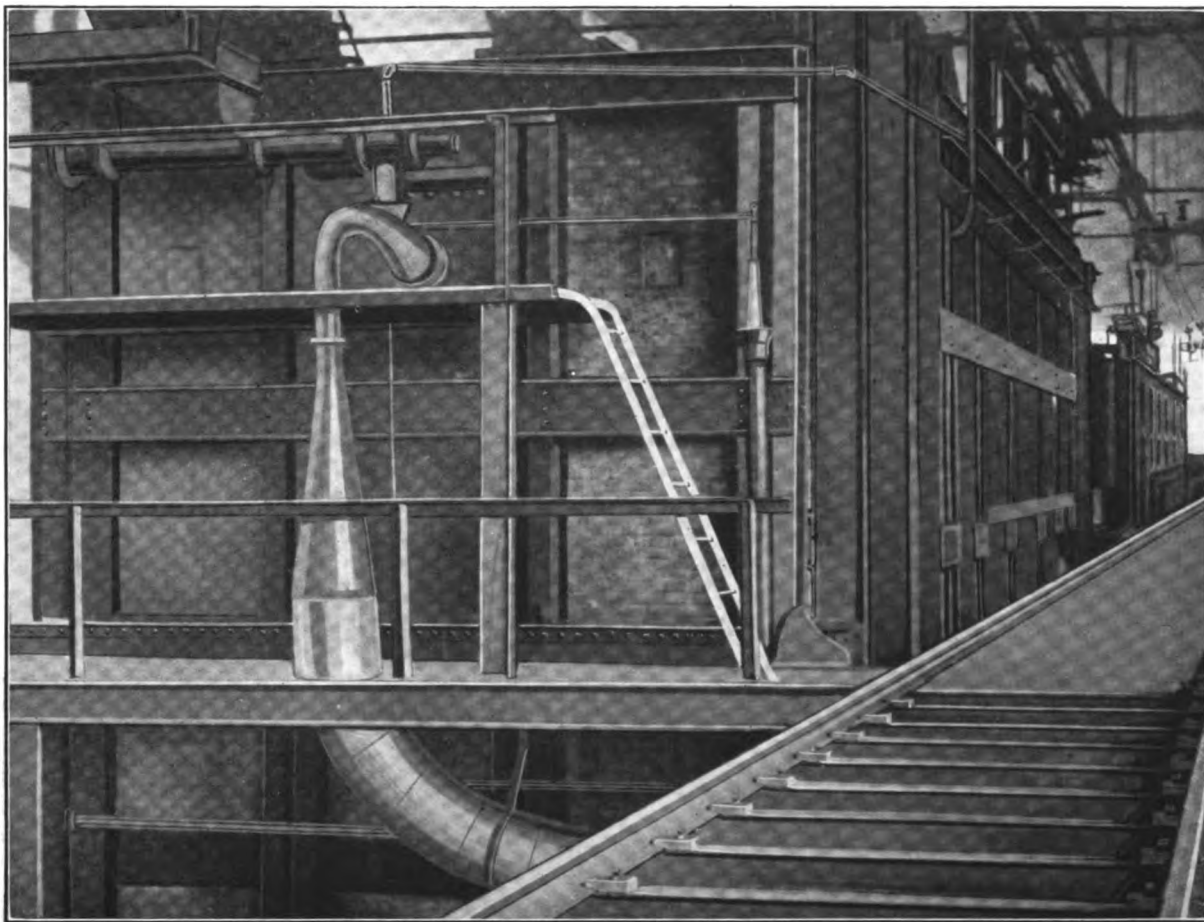
In the anthracite field there are large quantities of coal daily pumped back into the mines, which coal is a result of the washing and crushing operation, for bringing the coal to commercial sizes. This silt or washery waste coal carries as high heat value normally as the coals which have been operated upon. The president of one of the large coal companies in the East stated that from eight

GENERAL UTILIZATION OF PULVERIZED COAL

to ten million tons annually of this salt was pumped back into the mines to fill up old workings.

A number of the coal companies are now carefully investigating the application of pulverized anthracite or low volatile coals with a view to using this waste coal in pulverized form so as to obtain power from its use, mak-

from 5 per cent. to 10 per cent. of moisture as received, 25 to 35 pounds of coal are required to be burned on the grates per ton of coal dried. The cost of this coal is naturally based on the cost of the coal as received. The great variable in the cost of preparation in pulverizing coal then comes down to the labor item. The labor varies



END VIEW CHARGING SIDE 50-TON O.H. FURNACE, SHOWING PULVERIZED COAL APPLICATION

ing available coals of higher grade for the market, which they are firing at the present time.

The adoption of pulverized coal for any particular operation naturally depends on the cost of preparation or handling, which is a charge in addition to the fuel itself, which charge, however, in a great many cases is less than that where lump coal is used. The power required in a first-class pulverized coal plant per net ton of coal handled is in the neighborhood of 17 horsepower-hours per ton produced. This includes the power for crushing, drying, elevating and conveying, and delivering the pulverized coal to the conveyors leading to the point of use. The repairs vary slightly with the quality of the coal being handled, but, generally speaking, the repair costs for the pulverizing plant should be somewhere between 5 cents and 7 cents per net ton of coal handled.

The drier fuel is practically a constant, as the amount required per ton of coal dried with a given moisture content with standard driers will not vary very much.

In the Lehigh Valley district, where the coals carry

indirectly with the quantity of coal handled and the time or continuity of operation in the pulverizing plant. In other words, the question of labor cost is one directly affected by the equipment installed. One man can handle quite a number of machines, so that, in making up an estimate on the probable cost of pulverizing coal, careful consideration should be given to these statements.

Generally speaking, coal in fairly large quantities, from 50 to 100 tons and upward, can be pulverized and delivered to the furnaces at a cost from 20 to 50 cents per ton, depending upon the quantity handled. Nothing has been said, however, as to interest and depreciation, taxes, overhead and other burdens entering into the ultimate cost of preparation, as these are items which have to be considered in each specific case. For instance, the cost of a pulverizing plant, if it is to be operated 10 or 12 hours per day, would be considerably greater than an installation to turn out the same production in 24 hours. The cost of preparation will vary also with the investment, for with a given production, done in one shift, it

will naturally be accomplished at less cost than if it would require two or three shifts.

To make a positive statement as to the cost of any given sized pulverized coal plant to-day is rather difficult, in that the conditions governing every installation vary. Generally speaking, however, an ideal plant with a capacity of 100 tons of pulverized coal daily will cost to-day, with the present prevailing high prices, in the neighborhood of from \$300.00 to \$400.00 per ton of coal pulverized. The cost of a plant for 250 tons daily capacity of pulverized coal will be from \$250.00 to \$300.00 per ton.

To the cost of the pulverizing plant there must naturally be added the cost of the conveying system to the furnaces, also the storage bins, burners, etc., as well as the air supply.

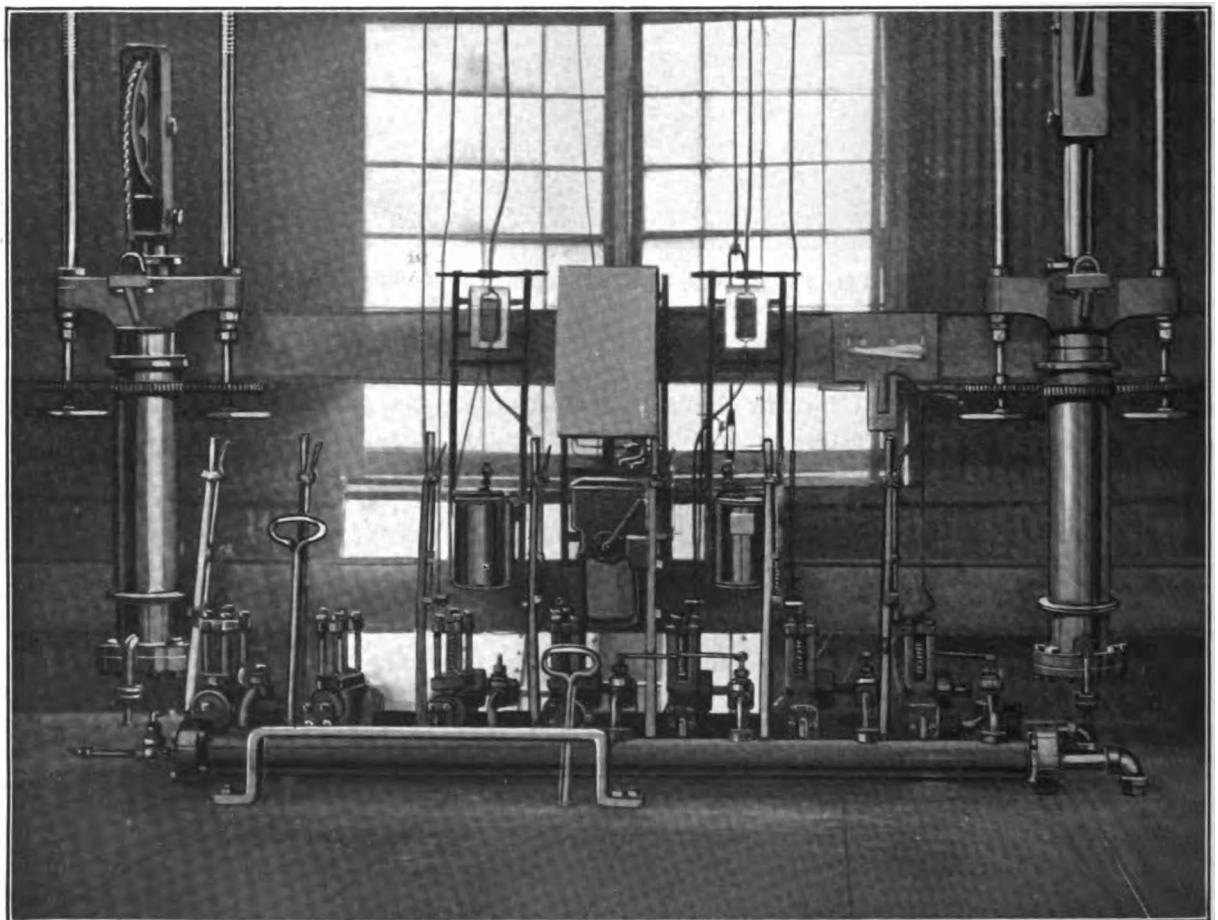
There are too many pulverized coal plants in existence to-day to permit or allow a careful engineer to be misinformed as to the ultimate cost of the preparation. The cost sheets of plants using pulverized coal for years are readily obtainable.

The subject of pulverized coal handling from the pulverizers to the point of use is also important. The application of any particular method depends upon the distance to which coal must be transported, as well as the quantity to be handled per hour. The general practice in plants

where pulverized coal has been used for a number of years and in plants where the capacity would be from about 50 tons per day upward is the use of screw conveyors for conveying the coal. These screw or spiral conveyors are mounted in dust-tight troughs. The gudgeon forming the connection between the different sections of the conveyor runs in chilled bearings, and when properly installed its upkeep is very low. They do not require much attention, and the bearings last for years, the coal itself acting as a sort of lubricant. Coal, after being pulverized, weighs only from 32 to 38 pounds per cubic foot, and is permeated with air flowing along the conveyors like a fluid. The horsepower consumption for distribution with this system is the lowest of any, and when properly installed this system is dustless.

There are other means of conveying pulverized coal, such as carrying the coal in suspension. More power, however, is required for furnishing air to carry the coal in suspension, and at such a velocity to prevent its building up in the blast pipes, than is used where screw conveyors are installed. The necessity of closing up every leak and the possibility of moisture affecting accumulations in the transmission lines make a system of this kind usually expensive to operate.

Another method now being developed is the conveying of pulverized coal thru pipes by means of compressed



VIEW OF CENTRALIZED REVERSING MECHANISM 50-TON O. H. FURNACE, OPERATION COMPLETED IN $7\frac{1}{2}$ SECONDS

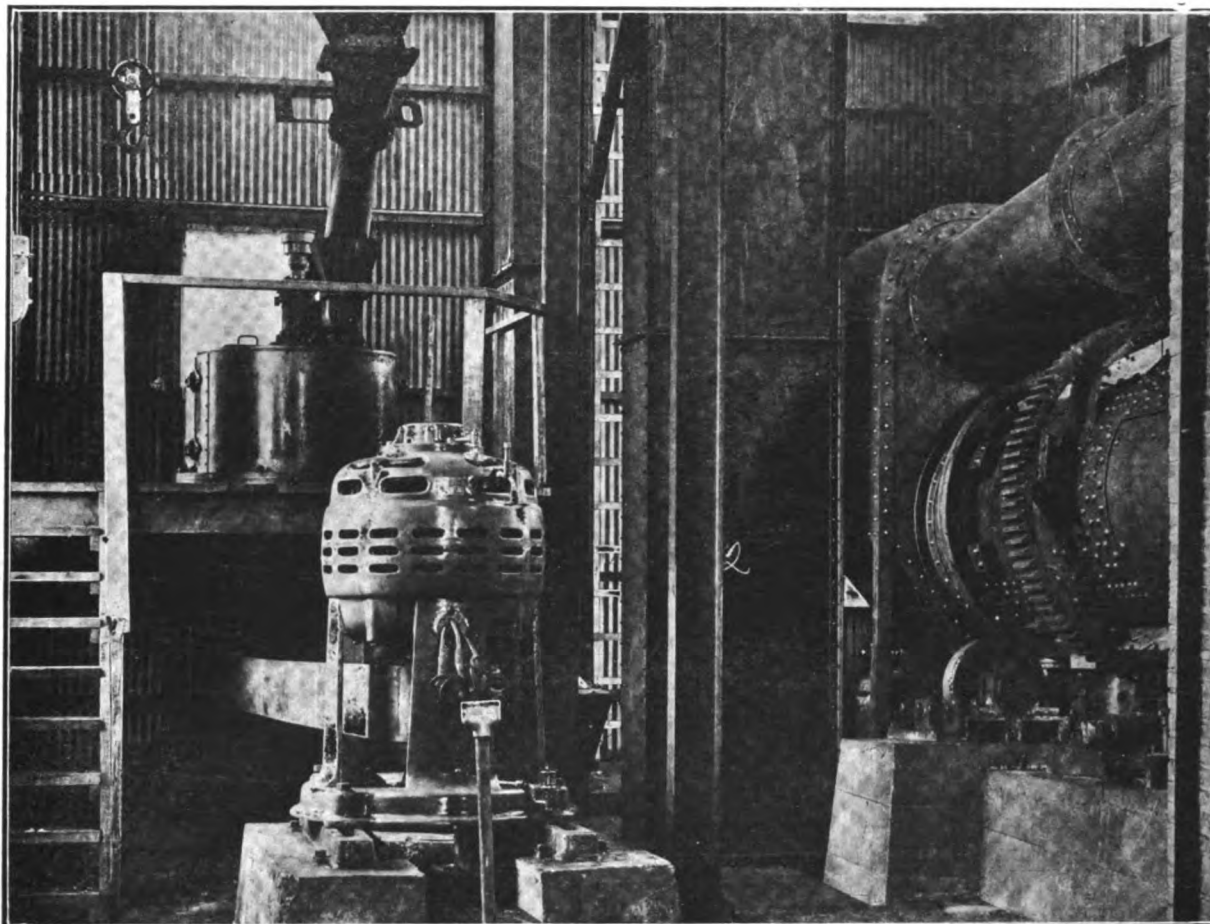
GENERAL UTILIZATION OF PULVERIZED COAL

air. With this system the coal enters the pipes in charges, compressed air being used as a means of propulsion.

Relief valves and cyclone collectors naturally must be installed so as to relieve the pressure after the charge

tity of coal is handled daily, or for a short distance. This system should be considered where coal is to be transported a long distance.

Summing up the whole subject, it may be seen that the use of pulverized coal has no insuperable difficulties



42" FULLER LEHIGH PULVERIZER, VERTICAL MOTOR AND DISCHARGE END OF INDIRECT FIRED ROTARY COAL DRIER IN A. T. & S. F. RY. COAL PULVERIZING PLANT AT MARCELINE, MO.

has been delivered to the receiving point. This system is installed in one or two plants, but its success and operation have not been sufficiently apparent to warrant its installation in plants where a fairly large quan-

to overcome, but merely those which have always hampered the introduction of new methods. Pulverized coal is here to stay, for it is very closely allied to the conservation of our natural resources.

INCREASED VALUE OF COAL IN 1916

FIGURES compiled by C. E. Leshar, of the United States Geological Survey, Department of the Interior, show that the total value at the mines of the coal produced in 1916 was \$867,125,638. Bituminous coal and lignite were valued at \$665,116,077, an average of \$1.32 per net ton, compared with \$1.13 per ton in 1915, an increase of 19 cents, or less than 17 per cent. Pennsylvania anthracite was valued at \$202,009,561, an average of \$2.30 per net ton, compared with \$2.07

per net ton in 1915, an increase of 23 cents, or 11 per cent.

The average value per net ton at the mines (exclusive of selling expense and stock shrinkage) of all anthracite shipped in 1916 of chestnut size was \$3.51; of stove, \$3.40; and of egg, \$3.32. The average value of pea size was \$2.10. The average values of the smaller sizes ranged from 67 cents per net ton for "boiler" to \$1.31 for buckwheat No. 1.

THE RELATION OF THE BANKER TO INDUSTRIAL CHEMISTRY*

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UNDER ordinary conditions and in normal times the spectacle of a banker presuming to address a body of chemists upon their exclusive and somewhat mysterious specialty, or indeed upon any other subject closely related to this specialty, would be rather unusual, and would suggest a boldness which quite consistently and even profitably might be applied to some more heroic, although probably not more difficult, task.

Just where the theories of banking and the practice of chemistry come together has not claimed the attention of banking circles to the extent its merit would appear to entitle it; and why bankers and chemists have not yet succeeded in breaking thru the wall of indifference separating them is a matter that properly may be made the subject of discussion and explanation.

However, the conditions under which we meet are not ordinary ones, and the times in which we live are not normal. Conditions are far from ordinary when thru the world men look out upon a situation strewn with wrecks of institutions upon which men had learned to depend for safety, security, and guidance, and where, as affecting the relations between men, race, creed, and kin have lost their meaning; and times are far from normal then, after a thousand years and more of Christian teaching, thought, and inspiration, Christian men consistently speak of saving the spirit of the world from the savage ferocity of Christian nations, and when into each thought there creeps the shadow of a fear that never again will the peoples of the world be able to get together in the delightful old-time relationships now seeming so far away. And so the task which, under other conditions, would be so difficult of treatment becomes easy and live and tangible, because in it is found the possibility of treating some of the wonderfully big things that have come into this new war-inspired field of national thought, in which institutions of the future must be created to take the place of those we have seen so ruthlessly destroyed.

These are wonderful days in which we live. Upon every hand are striking and unmistakable object-lessons pointing the way for us and guiding national thought and impulse. Doubts and uncertainties that for years have clouded our horizon have been cleared away in a day. Recently it was my privilege to attend the deliberations of three of the country's great business conventions—the National Petroleum Association, the War Congress of American Business, under the auspices of the Chamber

of Commerce of the United States, and the American Bankers' Association. Under any conditions these would have been unusual gatherings, but held as they were, under the stress of war, their normal importance was vastly increased. Many interesting subjects were discussed in masterly manner. Widely separated points of view and almost all possible shades of national business interest were represented.

They were not war conventions, nor were they characterized by any of the fervid war utterances with which the country was filled only a few weeks ago, and still, whatever the subject and however its treatment was begun, the discussion inevitably found itself moving along war channels, and the conclusions reached invariably were based upon war considerations. War was in the air and would not be denied. Another striking characteristic of these conventions was the highly constructive quality of the deliberations. No time was wasted upon appeals to patriotism or to the fighting spirit. The spectacular aspect of war was not in evidence. No attempt was made to explain our presence or motives in the war, and, above all, there was no note of doubt or uncertainty as to either the seriousness of the war or its intimate relation to our national life. It was as tho the diverse and conflicting business interests of the nation, in obedience to some unexpressed impulse, had found a motive so big and so truly national that in its presence the sectional and personal quibblings of times of peace and security were unable to live. A new American national spirit seemed to be in the atmosphere, and in it the newly discovered power of a great nation spoke eloquently. It was altogether splendid, and the lesson it taught was full of inspiration. If such a spirit can be applied to our unusual problem the solution should be easy and the determination of a proper relationship between even so divergent elements as chemistry and banking should present no serious difficulties.

The true relation of banking to chemistry is to be found in most tangible form in the very simple, easily understood, and well-known theory of practical business. The situation is not difficult unless we are unreasonably disposed to make it so. If the banker can relieve his function of the oppressive weight of self-constituted and unjustified importance under which it has struggled in the past, and bring it out into the open, and give it the sort of contact with other business institutions which it needs and deserves—and if the chemist can emerge from the somewhat mysterious atmosphere in which unfortunately he and his function have been enshrouded, and give the average business man and the banker a chance to realize

* Address delivered before the Philadelphia Section of the American Chemical Society at the Engineers' Club, October 18, 1917.

how tangible and how intensely practical a business institution chemistry really is, the solution of the problem will be found in understandable form in the practical working out of everyday business transactions.

To the banker or other layman chemistry is difficult and mysterious and seems rather apart from everyday business. A broadening of our general attitude toward the other man's specialty, fuller development of our powers of observation, and greater effort to discover true relationships between apparently unrelated things will work wonders toward creating in the world of business and finance thoro respect for the intensely practical business possibilities which exist in the subject of chemistry.

In this direction Europe has gone much further than this country in its coöperative institutions. Those of Denmark are particularly interesting because of their high development and because of the extent to which the practical spirit of coöperation dominates the entire situation. This wonderful country of less than three and a half million people, able in normal times to sell annually in London alone more than \$150,000,000 worth of bacon, butter, and eggs, and practically to dominate that city's trade in these commodities, has not failed to give the chemist his proper place in the nation's economic plan, nor has it failed to utilize its equipment and services effectively in connection with the daily simple business details. There the chemical laboratory is not a remote institution, resorted to only when normal methods of treatment fail, but rather an institution fundamental in even the simplest processes and those in which the most modest farmer possesses vested rights.

As a result of intelligent investigation and analysis, the Danish farmer knows the different soils as he knows his friends, and treats them with almost greater consideration. If a crop is not performing up to the standard fixed by the coöperative agricultural society, his attention is directed to that fact by the society and the situation is immediately made the subject of scientific investigation and treatment. If a milk product delivered to the coöperative dairy is deficient in some important element, the matter comes to the farmer's attention at once. The formula upon which his cows have been feeding is inspected and, if necessary, a change is made to suit the requirements of the particular case. If the eggs delivered to the coöperative egg export society are not up to the standard, his hens, their housing, diet, and treatment are immediately made the subject of investigation and again the remedy applied in whatever form is deemed most desirable, not by the farmer himself but by the scientific institution which speaks for the larger united interest of which the farmer is only a part. It is interesting, too, to learn that this service comes to the farmer not in a special or unusual way but as one of the ordinary details in the management of his farm, and practically without extra expense to him.

In the Philippine Islands a few years ago an effort was made, and with only modified success, to manufacture and introduce into the United States a lady's summer hat made

of the bamboo fibre. This is one of the most beautiful hard fibres in existence. It possesses every quality which reasonably could be demanded by the millinery trade for a reasonably cheap, light, wide-brimmed hat of fine finish and pleasing appearance. The bamboo is found in unlimited quantities in the Philippines, and the people are so expert in its treatment that a reasonably high-grade hat could be produced for not to exceed fifty or sixty cents. Such a hat, if it happened to be agreeable to the requirements of the American trade, should retail in the United States for from \$3 to \$4 or upward.

Just about the time this bamboo hat was beginning to promise commercial success in the United States there was developed a demand for hats in colors. The Philippine hat situation, because it lacked facilities for the proper treatment of bamboo fibre with color, was entirely unable to respond. It happened that there was not in the islands a color chemist. Experiments performed in the Government Bureau of Science and by private concerns were not satisfactory in their results. It was easy enough to color the fibre, but to treat it with fast colors without dulling the very desirable bamboo surface was found to be entirely beyond the equipment of the local situation. As a result, this hat, basically probably the best in the world of its general class, is practically unknown in the United States, and the Philippine Islands have lost a commercial product which, if properly developed, would represent at least half a million dollars per year.

It would be possible to spend an entire evening in describing a layman's impressions concerning the importance of the application of the powers of chemistry to the needs that have come under casual observation in different parts of the world. The Philippines, China, Manchuria, Japan, India, Korea, Formosa, the countries of Europe, and even our own country, furnish countless illustrations upon either the striking success with which chemistry has been applied to material problems, or the equally striking need for such application.

A banker once said that banking was unfortunate in that it was parasitic—that it lived upon the lives of others and created nothing of its own. This is altogether wrong—but, unfortunately, such a statement reflected a much too common estimate of the profession and an estimate for the existence of which bankers themselves are not a little to blame. If logically founded, properly equipped, and intelligently directed, the bank performs a business function in which the creative element figures as prominently as in production or manufacture or distribution.

The producer creates by transforming the riches of the earth into tangible and usable value, which he disposes of to his advantage. The manufacturer creates by changing the form and increasing the usefulness and, incidentally, the value of the product which he, in turn, disposes of, and to his advantage. The wholesaler and the retailer, without any essential change in the form of what comes from the manufacturer or the producer, sells the

product, probably to a greater personal advantage than either of the others.

The banker, in a spirit differing in no essential from that which actuates the producer, the manufacturer, the wholesaler, and the retailer, comes into these processes of production, treatment, and distribution even more frequently and certainly not less importantly than any of the others. Indeed, it might be said that *his* is the most important function of all in the carrying on of these processes.

The bank makes it possible for the farmer, the miner, and the lumber man so to conduct their producing activities that if they proceed intelligently and consistently they always can find the financial means whereby operations may be continued and properly extended. In even a greater degree, the manufacturer, the wholesaler, and the retailer have learned to depend upon the bank for assistance. The treatment of commercial paper whereby the immense commercial credit of the country may be utilized, transactions in connection with foreign trade, the conservation and investment of funds, the treatment of stocks, bonds, and securities—all are functions performed by the bank and recognized by business men of all classes as vitally important in the nation's commercial life.

The true relation of banking to chemistry is found in the theory of practical everyday business. This theory must be taken seriously and literally by both banker and chemist if they are to derive the greatest benefit from each other and from business. Regardless of tradition and of possible personal inclination, they must descend from their respective pinnacles, whether of financial exclusiveness or scientific preoccupations, and get together in the intensely practical and really very comfortable atmosphere which the thoro up-to-date business man of today has created and prepared for them. If in doing this it becomes necessary to disturb an occasional delightful fiction or to smash an occasional professional idol, both may be done to the benefit of all concerned.

Just what transformation in the chemist and in chemical industries must take place to produce the desired result the chemist himself knows best. A substantial movement in the right direction has been made. If a suggestion from the financial viewpoint might be offered, it would be this—do not be exclusive and do not allow excellent arguments upon the business and financial merits of industrial chemistry to be wasted upon yourselves and each other. Hold conventions and meetings and have discussions, but do not stop with these. Get outside the chemical field into the conventions and discussions of business, of industry, of finance, and *there* tell the story of the wonders of chemistry and prove its just claims. Do not allow the consciousness of the merit of your proposition to blind you to the fact that to others who have not enjoyed such close contact with it as you have it is not so clear. Realize that the chemist, so far as the business world is concerned, occupies the position of the business man who has something to sell, and, in common with that business man, is expected to make the first move.

Study the selling methods of the business man, and discover the importance he attaches to the theory of following the line of least, instead of greatest, resistance to results. Try to meet the business man and banker upon their grounds instead of upon yours, or at least upon some pleasant neutral ground on which their present indifference toward your interests will not exist. Try to get the banker's point of view—to see how natural it is for him to follow the line of least resistance in his investments, to give first consideration to the definite, tangible, well-developed, and thoroly explained propositions that come to him thru recognized channels rather than to the perhaps wholly meritorious investment opportunity to which industrial chemistry rather casually calls his attention. If your efforts are directed into these channels, it is almost certain that before long it will be found that the present objectionable features in the attitude of the banker toward chemistry will have disappeared.

The banker has no quarrel with the chemist nor with industrial chemistry. The tendencies of modern banking are well suited to the future development of a more active financial interest in the possibilities of industrial chemistry than has existed in the past. The most advanced school of banking thought, that has secured a large and rapidly increasing representation thruout the country, inclines strongly toward the theory of logical intimacy in the relationships of the banking function to business activities.

The banker of to-morrow must be, first of all, a business man. He must be able to get away from the fictions of former years, in which the banker, because of his intimate association with money, became obsessed with the idea that he and money were of the very essence of each other and that they mutually reflected each other's virtues for the general edification of mankind. He must be able to speak the language of business, to meet the business man upon business grounds, to discuss with him business problems, and, by his ability to provide the remedy frequently required, must even prove himself to be the better business man of the two. He must realize that, in the larger sense, the bank must depend upon business, and not business upon the bank—that in the great mass of institutions indispensably connected with business activities the bank is only one, and not by any means *the* most important one. This banker of the future must enter into the business life of the community more extensively and more actively than in the past. He must so equip himself and his institutions as to be fully prepared to perform whatever function may be submitted to him by the business of the situation of which he is a part. Upon business questions which come to him for treatment his function must be that of a specialist, a sort of physician for the treatment of ills which affect the natural life of business.

It may seem that this is an unreasonably high standard of business excellence required of a man already deeply immersed in the purely financial details of his institution, but the developments of modern business leave no doubt as to the nature of its requirements upon him.

(Continued on Page 599)

THE UTILIZATION OF NITRE CAKE*

W. W. RHODES

CHEMICAL ENGINEER, E. I. DU PONT DE NEMOURS & COMPANY

NITRE cake is a product in the manufacture of both nitric and sulphuric acids.

Up to the year 1907 it was not considered as a by-product, but as a true waste product, and the chief problem in connection with it was the method of disposal. Most acid plants are located adjacent to streams, and the nitre cake was run into them.

Even as late as 1912 some writers refer to it as a true waste product, and it has been an up-hill battle successfully to educate manufacturers both as to its merits and its uses, especially as the chemical profession at large had very little good to say of it.

Nitre cake, such as the duPont Company produces, is a fused salt containing approximately 78 per cent. sodium bisulphate, 20 per cent. normal sodium sulphate, a trace of ferrous sulphate, some silicious matter insoluble in water, and a small amount of moisture. Its acidity is equivalent to 32 per cent. sulphuric acid, and in all its reactions it may be looked upon as containing this amount of available acid.

The specific gravity of nitre cake is about 2, varying with the acid content, but in our engineering practice we reckon the solid cake as weighing 126 pounds per cubic foot and piled in slabs 100 pounds per cubic foot.

Nitre cake is readily soluble in warm or in hot water. The following amounts of nitre cake will dissolve in 100 parts of water at the temperature stated and achieve a saturated solution in the time stated:

104 parts at	30° C. in	105 minutes.
124 parts at	60° C. in	45 minutes.
130 parts at	80° C. in	30 minutes.
160 parts at	100° C. in	30 minutes.

The specific gravity of a saturated solution of nitre cake is 28° C. in 1.44. Saturated solutions will contain acid equivalent to 16° to 18° B. sulphuric, depending on the temperature.

At very low temperatures the acid sodium sulphate is broken up and the solution behaves like normal sodium sulphate dissolved in sulphuric acid. Attempts have been made to separate the normal sodium sulphate from sulphuric acid by this means, and temperatures as low as -23° C. have been tried. However, it was found that the sulphuric acid would contain about 10 per cent. sodium sulphate and the sodium sulphate about 9 per cent. acid, and that the highest acidity obtainable is 29 per cent.

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DuPont nitre cake must not be confused with the nitre cake from the Chamber Sulphuric Acid process, which sometimes contains as much as 40 per cent. available sulphuric. DuPont nitre cake is the product of a chemically controlled operation and contains no nitric acid. This is not true of many cakes which contain appreciable quantities of nitric acid, which is very detrimental to their industrial use.

The chief industrial use of nitre cake at the present time is in the pickling of iron and steel, copper, and brass. Pickling refers to the process of removing oxide scale from the surface of metals, such scale having been formed during some heating or heating and rolling process.

For pickling purposes, wooden tubs are used, into which, either by hand or by mechanical contrivances, the metal is immersed in the solution. Pickling is done both in agitated solutions and solutions in quiescent state.

When pickling with nitre cake it is customary to make up in the tubs a solution containing $\frac{3}{4}$ to $1\frac{1}{2}$ pounds nitre cake per gallon of water, which is equivalent to a 2° to 5° B. acid solution. Certain grades of steel, notably high-speed steels for drill stock, require only $\frac{3}{4}$ to 1 pound of nitre cake per gallon, while others require more, and in extreme cases even the $1\frac{1}{2}$ pounds formula is exceeded. The solution is kept hot by means of steam coils, which are placed conveniently in the tub, and if solution is to be agitated, cleats are nailed upon the bottom of the tub to keep the detached scale from rising and fouling the pickling liquor.

Speed is essential in pickling, and so the metal is removed from the pickling tank as soon as the scale is removed and washed in water, then in a lime bath to neutralize the last traces of acidity, and then in water again. When the acid content of the pickling solution is decreased materially after running through a quantity of metal stock, the bath "slows up"—that is, does not pickle so rapidly as it did when it was fresh. More nitre cake is then introduced, and this then becomes the procedure until the bath becomes high in sodium sulphate and further additions of nitre cake fail to maintain its speed. At this point part of the bath is siphoned off and a fresh solution of water and nitre cake introduced. At the end of each run, when there is time available, an entirely fresh bath is made up.

One pickling suffices in the case of most products, but in the making of some classes of enamelled cooking ware utensils two picklings are resorted to. After the first pickling the ware is exposed to the air for a few hours until a coating of rust is formed, and then it is pickled a second

time. This is done to break down a glaze formed in the spinning operation and etches the ware so that it will take the enamel. In stamping hollow ware an irregular compression of the steel results, and the spinning operation is simply the revolving of the ware against a piece of metal, and the pressure incident to the operation brings about a smoothing out of the sheet and causes a disappearance of any irregularity of the vessel. This same spinning puts over the parts of the steel which have been most compressed a kind of glaze, which is the glaze above referred to.

In some foundries the castings come from the moulds with particles of sand and scale firmly adhering to them. Neither sulphuric acid nor nitre cake will remove this sand entirely, and so sand blasting has to be resorted to. To sand-blast a casting requires a considerable length of time, say twenty to thirty minutes for each casting. If, however, the castings are pickled for from one to three minutes in a solution of nitre cake and then sand-blasted, the time required is less than half of that required for the sand-blasting process without preliminary pickling.

Nitre cake has a distinct advantage over sulphuric acid for pickling purposes because it removes the scale efficiently without attacking the metal materially. In the case of wire which has been stored out of doors for a long period of time, and consequently has accumulated a good deal of rust, it is found that after the wire is pickled in nitre cake it is nearer to gauge than when pickled in sulphuric acid. This is explained by the fact that the sodium sulphate has a cushioning effect and protects the iron, but you can readily see it is simply a question of disassociation.

Nitre cake will not pickle steel in which there has been a segregation of carbon due to improper manufacture. It removes the scale but leaves the carbon. It will therefore detect faulty steel stock, which sulphuric acid will not do.

Nitre cake is now widely used for pickling purposes; it has as much if not more speed in pickling than sulphuric; it can be handled easily and does not burn the workmen like sulphuric; there are no carboys to be returned when it is used, and the cost of pickling per ton of steel is materially reduced.

It is used to pickle gun barrels, bolts, and all classes of ordnance and munitions, and in every pickling operation where sulphuric acid has formerly been used. It is used in pickling copper and brass and gives very good results. Even the makers of optical lenses employ it to remove the iron abrasive that has been used to polish the lens.

NITRE CAKE IN THE TEXTILE INDUSTRY

Nitre cake is now being used in the textile industry to replace Glauber's salt and sulphuric acid, which are commonly referred to as mordants, but which are sometimes classed as mordanting assistants. To cite a specific instance, it was the practice in a certain rug mill to employ 18 pounds of 66° acid and 70 pounds of Glauber's to every 300 pounds of woollen yarn that it dyed. At

about one-fifth of the cost to it, it now uses 45 pounds of nitre cake to replace these chemicals. The regular dyeing practice when using nitre cake is to dissolve it in the hot water used in the dye vat, then the goods are introduced and the vat or the goods agitated until the nitre cake solution is well soaked in. The mordants and dyes are next introduced, as in the regular procedure. It was the usual custom, when employing sulphuric acid, to run the acid together with the dye so as to set it, but it has been found that when nitre cake is used the work is done just as well, even though the vat has become acid before the colors are run.

Nitre cake is also employed as a coagulant in the cuprammonium process for making artificial silk from cotton. It is used in the coagulant bath, just when the cellulose dissolved in the copper and ammonium salts is acidified and coagulated.

NITRE CAKE FOR HYDROCHLORIC ACID MANUFACTURE

Nitre cake is largely used in the manufacture of hydrochloric acid. It is crushed and ground and mixed with the theoretical amount of common salt, and calcined in a mechanical muffle furnace. This process presents no chemical, only mechanical, difficulties. The furnace should be so constructed that the mixture has a thorough preheating before it comes in contact with the hottest part of the muffle where the conversion takes place. If tourilles are used, cements containing oil cannot be used to join the pipes, as even the smallest amount of oils will coat the surface of the water in the tourilles, and consequently little gas is absorbed. Towers are probably most efficient in the absorption of hydrochloric acid gas.

NITRE CAKE FOR SANITARY PURPOSES

Nitre cake is the chief constituent of two water-closet cleaners now on the market. These cleaners are composed of about 90 per cent. nitre cake and 10 per cent. common salt, and are very effective in removing iron stains from the bowls and to some degree sweeten the pipes.

At one time a sample shipment of nitre cake was obtained by a man in Missouri who desired it for experimental purposes. It did not do the work he expected it would do, so he conceived the notion that it might be a good thing to apply to the ponds in the vicinity of his town to kill the larvæ of flies and mosquitoes. It did this work so well that the town did not have a fly or mosquito all summer. This problem has been submitted to the New Jersey Experimental Station, and it has reported that nitre cake is very effective for this purpose.

Soda Alum:

Soda alum is used as a substitute for cream-of-tartar in the baking trade and is also employed in the manufacture of paper. A patent for making it by the use of nitre cake was granted to John Fleming White, of Buffalo, N. Y., and rights under it have been assigned to a prominent Middle-West chemical company, which makes large tonnages, using nitre cake. The process, as stated in the

THE UTILIZATION OF NITRE CAKE

patent, is as follows: To a solution of nitre cake having a density of 35° B. is added ground bauxite or alunite until the acid is fully neutralized. The proportion of aluminum sulphate present is less than that required for the formation of soda alum, which contains in the calcined state about 71 parts of aluminum sulphate and 29 parts of sodium sulphate. In order to increase the proportion of aluminum sulphate there is added a watery solution of aluminum sulphate made by treating aluminum hydrate with sulphuric acid. The ingredients are mixed, heated to near the boiling-point, and diluted with wash waters from a previous bath until the density of solution is from 25° to 30° B.

The solution is then allowed to stand until the insoluble matters, such as clay and silica, settle out. The clear liquor is then drawn off and enough sodium nitrate or nitric acid added to completely oxidize the very small amount of iron compound present. The liquor is then concentrated to 56° B., cast on a stone floor, and the alum calcined.

For this process it is necessary to have arsenic-free nitre cake, because the soda alum must pass the food inspection. Nitre cake made from sulphuric acid, which in turn has been made from a sulphuric burning process, usually contains no arsenic, but sulphuric made from pyrites contains traces of arsenic.

Accelerating Lime Plaster:

There is in very successful use to-day a lime plaster composed of 85 per cent. hydrated lime, with an addition of 15 per cent. of a highly aluminous blast furnace slag to which has been added an amount of nitre cake. The nitre cake causes a more rapid set than when the plaster was made without its use, and the hardening throughout the mass is accelerated.

Live Stock Conditioners:

Nitre cake has been purchased by makers of live stock conditioners, who neutralize it with soda salts and prepare Glauber's for use in their preparations.

Acidifying Phenolate:

Nitre cake has been successfully used in acidifying sodium phenolate in preparing phenol and found entirely satisfactory. For this purpose there must be no nitric present, as it discolors the phenol. The salting-out effect of the nitre cake also recommends it for this purpose, and a little ammonium sulphate used with the nitre cake solution will protect against traces of nitrate.

Nitre Cake for Soapstock:

In the refining of vegetable and animal oils by the usual process of treating the crude oil with an aqueous solution of an alkali and agitating, the free fatty acids are neutralized. The mixture is then heated to a suitable temperature until the oil breaks, and then it is allowed to stand until the "foots" or alkaline salts of the free fatty acids are separated out.

Foos are then treated with a solution of 110 pounds of nitre cake in 500 pounds of water. This is sufficient for 500 pounds of soapstock. The mixture is well stirred

and the temperature maintained at approximately 85° C. for three hours. At the end of this time the "cutting out" of the oil should be apparent. If such is not the case, heating and stirring should be continued until separation or cutting out takes place. To effect a clean separation of the oil from the acid liquor, the mixture is allowed to stand over night without cooling below 40° F. The acidified stock should form an upper layer of dark but clear, bright oil. This oil may then be drained off and shipped to the soap factories. The process is the invention of Dr. Jeffrey Stewart, of Philadelphia.

Defibreization of Rubber Scrap:

Nitre cake will successfully defibreize certain grades of rubber scrap, but it is not successful on grades which contain large amounts of rubber substitutes and reworked rubber. At one plant the scrap was composed chiefly of solid truck tires, with a fibre base, the fibre being entirely, or almost entirely, on the outside of the tire proper. The scrap was treated in a 50 per cent. nitre cake solution at a temperature of 100° C. The fibre was destroyed enough to be removed in a subsequent operation. When nitre cake alone will not do the work, solutions of nitre cake in sulphuric acid will frequently be efficient and will reduce the cost materially.

Neutralizing Lime in Talc:

Some clays which were not a true talc have been rendered useful for paper sizing by neutralizing the lime in the clay with nitre cake. When nitre cake was not used there was a foaming in the beaters.

Fertilizer:

Several fertilizer manufacturers are now using large amounts of nitre cake to replace the sulphuric acid formerly used to dissolve the phosphate rock. We have no information available at present on the details of this process.

Leather Industry:

The use of nitre cake has been suggested in connection with the one-bath chrome process to replace the acidified sodium bisulphate ingredients. It might also be used in connection with calcium or magnesium salts in plumping.

Mining:

Ores containing carbonates have been treated successfully with nitre cake in the flotation process. Certain ores or matters are both fluxed and leached with nitre cake.

Recovery of Wool Grease:

In years gone by the question of disposing of the waste waters from our large wool scouring industry was not a difficult one to solve. The plants were located adjacent to streams and the wash waters were run into them. However, many of the states have passed stringent laws prohibiting this practice, and the wool scouring plants have been forced to seek new methods of disposing of their waste water. The process that bids fair to be

most successful is the invention of Clay Littleton, of South Barre, Mass. It has been tried out at one of the largest scouring plants in New England and has been a great success. In the Littleton process the suds or waste waters are pumped in a continuous stream over a device for catching the hair that has slipped by the operation. This device also serves as a filter to remove any sticks or foreign matter that might have gotten into the water. The suds then flow thru a box containing nitre cake, which is a dissolver and which adds an exact amount of nitre cake to the waste waters. They then flow into a cracking tank which is heated by steam coil and maintained at a fixed temperature. After a period of time the wool grease rises and separates on top of the water solution of nitre cake and is skimmed off to a second tank, where, on standing in the cold, water separates out and is decanted. The grease may then be pumped to a refining system which separates it into several grades by means of solvents. Mr. Littleton has made many improvements in the refining process, and the cost of refining has been reduced from $1\frac{1}{3}$ cents per pound to $\frac{1}{4}$ cent per pound. The water from this process contains 2 per cent. solids which contain 16 per cent. K_2O , so that they can be profitably evaporated for their potash content.

Nitre cake is more efficient in this process than sulphuric acid, because the water layer has a higher specific gravity than a similar water layer of sulphuric acid and the grease separates more completely.

NITRE CAKE IN THE PAPER INDUSTRY

Many of you have doubtless read in recent issues of the *Saturday Evening Post* of the young man who fought for sulphate pulp. The Kraft paper industry is becoming of great importance in the United States at the present time, because of the shutting off of imports of Swedish pulp and paper. It is obtaining such a foothold that it will probably survive competition after the war.

Mr. Bayard H. Morrison, of Philadelphia, proposes a modification of the present process for the manufacture of sulphate pulp whereby nitre cake (sodium acid sulphate, $NaHSO_4$) is substituted for normal sodium sulphate, Na_2SO_4 (salt cake). In order that the details of these proposals may be plain it seems advisable to outline the sulphate process as at present practised.

The cycle is begun by treating the wood chips in a digester with caustic soda under pressure. The non-cellulose content of the wood is unaffected and a fibre obtained which is suitable for the manufacture of a grade of paper known as "craft." After the digestion of the wood is completed the so-called "black liquor" is drained from the chips. In the process of digestion only about 15 per cent. of the caustic value of the liquor is lost. This black liquor is therefore treated for the recovery of its caustic value. This is done by concentrating in vacuum evaporators to about 32° B. and then evaporating in open pans at atmospheric pressure until the liquid is sufficiently viscous to be only slightly fluid. It is then introduced into a rotary evaporator, where it burns sufficiently to char the organic content which it contains as a result of

the digestion. From this rotary evaporator the material comes out in the form of a paste and is next introduced into smelters, where the sodium compounds it contains are changed into carbonates thru the reducing action of its carbonaceous content. At this point it is customary to introduce sufficient sodium sulphate to make up for the losses which took place in the digesters. Thru the action of the carbonaceous content of the black liquor and a certain amount of carbonaceous matter which is introduced with the sulphate, the sodium sulphate is reduced and changed to sodium sulphide, Na_2S , and sodium carbonate, Na_2CO_3 . The product of the smelters is, after cooling, leached with water, giving a solution of sodium sulphide, sodium carbonate, and whatever sodium sulphate went thru the smelters unreduced. This solution is then causticized with lime, producing sodium hydroxide in solution and a precipitate of calcium carbonate.

The sodium sulphide and the sodium sulphate are not causticized to any appreciable extent. The insoluble calcium carbonate, or "grout," as it is called, is run to waste, and the caustic liquors go again to the digesters for treatment of a further lot of chips. This cycle continues indefinitely, the caustic losses being made up each time thru the introduction of further salt cake.

Previous efforts have been made to introduce nitre cake in the sulphate process, but apparently without success. One method was to introduce nitre cake directly into the smelters instead of the neutral sulphate. This was not successful, due to the destructive action of the acid fumes generated in the furnace. A partial substitution of nitre cake for salt cake has been attempted, but the low melting-point of the nitre cake causes it to fuse, occlude lumps of the evaporated black liquor, and carry them thru the furnace unreduced.

Mr. Morrison does not propose the use of the nitre cake as such, but its neutralization thru the use of the calcium carbonate (grout), which is ordinarily run to waste, this procedure being made a part of the process. The reaction would be as follows:



The sodium sulphate remains in solution, the calcium sulphate precipitates, and the carbon dioxide is evolved as a gas. This reaction is carried on with wash liquors from the grout in order that no additional amount of evaporation will be necessary. The reaction is also carried out with such an amount of water that the sodium sulphate is obtained in saturated solution, thus insuring the minimum amount of evaporation. The sodium sulphate solution is mixed with the black liquor at some time after it comes from the vacuum evaporator. The exact point of mixture is immaterial as regards the final chemical results.

Mr. Morrison proposes that the carbon dioxide generated thru the action of the nitre cake solution (sodium acid sulphate) on the grout (calcium carbonate) be run into the black liquors before entering the vacuum evaporator, thereby changing the sodium hydroxide into sodium

(Continued on Page 599)

TWO CONVENTIONS

JAMES F. McCrudden, Member

CHIEF, DIVISION OF HOUSING AND SANITATION, BUREAU OF HEALTH

TWO conventions of much importance in relation to the present international war were held during the week of October 15 to 20, 1917.

The Sixth National Conference on Housing in America was held in Chicago on October 15, 16, and 17, and the Forty-fifth Annual Meeting of the American Public Health Association in Washington, D. C., on October 17, 18, 19, and 20, 1917.

Both conventions furnished war programs, and at no other time in the history of these Associations were engineering features given such prominence. It became very evident in the Housing Conference that in those cities where much industrial activity is displayed, and particularly in those communities that have assumed large proportions of war work, housing famines are quite conspicuous and some immediate remedy therefor will have to be forthcoming. The convention felt that the real estate men cannot be of any material help in this exigency, because of the high percentage of houses occupied, with no other houses fit for human habitation available. Industrial centers are already overpopulated in relation to housing, and with house-building at a standstill, various remedies were given wide discussion.

Reduction in cost was considered and much comment and encouragement given to standardization in relation to construction, and particularly with reference to building laws. Omission of non-essentials, conservation of ail waste, and advisability of concrete construction were also presented. Sufficient data have not as yet been presented to advise concrete construction in the building of small houses. It was the opinion of many that the uncertainties involved in this type of construction would not warrant, at this time, any experiments on a large scale in this method of house-building. Recommendations were made that building laws should be standardized in principle, in order to encourage the tabulation of definite information that would bring about reduction in the cost of workmen's dwellings.

The conference sought to make the impression that housing is indeed a war problem of much magnitude, and it was the consensus of opinion that England's experience may be of advantage to this country, in that the Government should aid in financing the building of workmen's houses adjacent or in the vicinity of war industrial work. Housing becomes a war problem in relation to reduction in "turn over" of labor in the efficient production of war material. For this reason the Labor Committee of the Council of National Defense has appointed a Housing Sub-committee, the chairman of which, Philip Hiss, has very recently submitted a comprehensive report

on the importance of immediate action by the Government in relation to housing questions. This was accepted by the Conference as very gratifying.

It was shown that the experience of our allies indicates that the engineer in charge of production must give serious thought to providing sanitary and hygienic homes for workers in order to meet the demands of production and other requirements. England's endeavor to coördinate production and housing, in the "Well Hall"* operation, led to the employment of a city planning engineer who has produced what Mr. Edward C. Culpin, secretary of the International Garden Cities and Town Planning Association, states to be "easily the first thing in cottage plans and elevations for the whole world."

Well Hall is situated about one mile from Woolwich and consists of some sixteen hundred workmen's houses built entirely of permanent construction. There are four types of houses of from two to four rooms with bath, the rentals ranging from seven shillings to fifteen shillings and sixpence a week. The English Government decided that the margin of difference between permanent and temporary construction was very small, and, in spite of urgent necessity, adopted the permanent enterprise rather than a merely temporary one. The precedent has now been set by a country having gone thru all the experiences incident to war production, and it will be interesting to note what thought or action will be taken by this country to relieve the present housing famines.

The production engineer is at the present time very much interested in the reduction in "turn over" of labor, and as a consequence all large employers of labor have delegated their representatives to determine what more can be done to effect stability in labor employment.

"It is a clean-cut proposition of dollars and cents with a desire to produce a maximum for government needs" was nearly the unanimous confession of all such delegates, and, while nearly all large industries have considered the problem of properly housing employees, nevertheless there has not yet been the anticipated satisfactory reduction. Many solutions were offered—transportation, environment, rentals, reduced cost of construction, the desirability of the employer also acting as landlord, and the difficulty of maintaining a real estate business in conjunction with other business.

One of the most important and interesting papers of the Conference was that by Major W. A. Starrett, of Washington, D. C., in charge of construction of the sixteen army and aviation cantonments. His work is so

* Described and illustrated in the *Journal of the American Institute of Architects*, September and October, 1917.

familiarly known to all engineers that nothing can be added to the wonderful achievements of the Government in the laying out and building of those sixteen large cities.

Bunk-houses, boarding-houses, and labor camps as temporary expedients in war time were discussed, the verdict of most of the delegates being that at this time it is folly to throw away money on such makeshift expedients, and that nothing is harder to get rid of than temporary buildings.

The "Zoning of Cities" was very ably presented by Lawson Purdy, president of the Board of Taxes and Assessments, New York City, and vice-president, Districting Commission, City of New York. Mr. Purdy presented the fundamental principles of zoning law in stating: "In a city there must be some height above which all the buildings should not go; there must be some bulk beyond which all the buildings should not spread out; there must be a proper relation between the number of people and buildings and the street facilities for vehicular and pedestrian traffic; there must be a proper relation between the open spaces, the windows, and the mean height and bulk of buildings, so that all of them shall have adequate light, air, and means of access to the streets. Even if such a law should be held unconstitutional, it would be advisable to amend the constitution, and it will be felt by that time that it is so vital and so necessary for the welfare, health, and the very lives of the people who dwell in the city that anything will be done necessary to bring about this great reform."

The War Programs of the American Public Health Association exemplified the importance and high standing of the engineer in the present world-war.

Preventive medicine must play a very important part in the present war, and much of the responsibility must fall to the engineer. The Conference presented reports of what has been done in the sixteen cantonments relating to the housing of the forty thousand men in each camp, the water supply, sewage disposal, refuse collection and disposal, and elimination of mosquito and vermin-breeding conditions. In all of these the engineer was the agent in the preventive measures, but a warning was issued to those engineers not in service that much still is to be done. The engineer, it was pointed out, will be the man to help in the conservation of *all* things that will have a bearing in the war work. The conservation of waste is an engineering problem, and engineers in civil life must give attention to coöperating with the Government and its efforts to effect savings so essential at this

time. In the general system of sanitary supervision of industrial diseases in war industries, in the establishing of practical standards for factory sanitation, in factory illumination, in prevention of compressed-air illness, in the establishment of working standards for heating and ventilating, and in serious thought in reference to the replacement of men by women in war industries, as well as industrial fatigue, are subjects which must necessarily interest the engineer solving problems pertaining to war production. The Conference recognized the value of the engineer's share of the work to be done that, aside from applied medicine, that work was a most important factor to be relied upon in the winning of the war.

The program of the Section on Sanitary Engineering brought out much new scientific data, after most careful research and study on such important subjects as "Air Supplies," "Sewerage and Sewage Disposal," "Control of Waterways, in Relation to the Fundamental Principles of Sanitary Control and Code of Regulation for Sanitary Control." The papers on "Refuse Collection and Disposal," and the "Effect of the War on Production of Garbage and Methods of Disposal," gave much information to municipal engineers in the handling of these engineering features of a municipal government.

In summarizing the things of special interest to the engineer, it was made apparent that there is a shortage in man-power for the carrying on of the industrial work required by the war, and study must be given to the importance of conserving all the forces now in our possession. In the replacement of engineers to fill the places of those enlisted in service, the importance of maintaining high standards must be acknowledged, and for the preservation of the health of those engaged in civil pursuits, as well as in the production of war material, the engineer must devote his energies and must accept his position as a leader. In the preservation of the health of the community at large, including industrial as well as other workers, the engineer will be "doing his bit" in giving maximum production, in preparing an army of physically fit and able-bodied men for war service, and providing for displacements by the employment of women, by insisting that our forces, both in material and men, are properly conserved, by providing sanitary and hygienic conditions in places of employment, as well as in the homes, and in the scientific control of all activities of the Federal, State, and municipal governments, requiring engineering supervision and having direct bearing upon the life, health, and comfort of the community.



THE MUCH-ABUSED TERM "MASS" IN ENGINEERING CALCULATIONS

By CARL HERING

THERE is probably no term used in engineering calculations the proper application of which has created so much confusion, is so voluminously discussed in text-books, and is so muddled in the mind of the average student as that very useful tho much-abused term "mass." The physicist disposes of the whole matter in his formulæ by the simple and always safe process of representing mass by the letter m or M , and stating that the gram is a unit of mass. This seems to satisfy him, and he hands these formulæ over to the engineer in this form as tho they were a finished product, when in fact some of them are only "half-baked." The engineer, in applying these valuable formulæ or laws of nature in his work, must be able to get tangible, concrete results in pounds, kilograms, feet, meters, seconds, foot-pounds, etc., but when he expresses the masses in some of these formulæ in terms of the usual well-known units of mass, he sometimes finds that he gets totally wrong results, about 10, 30, or 1000 times too great.

Engineering text-books that have some consideration for their readers generally state what units the letters in a formula represent; and these books also tell us that grams, pounds, kilograms, etc., are perfectly proper units of masses, and that, for a constant value of gravity, a gram of mass weighs a gram, a pound of mass weighs a pound, etc., hence that masses may be correctly measured and expressed in terms of their weights (for that value of gravity). But these books add that when using such formulæ as $mv^2/2$ for the energy in a moving body, in which m stands for the mass, these masses as expressed by their weights must first be divided by g , the acceleration of gravity, before they can be correctly substituted for the m . Every one knows that when a mass of a pound drops a foot, a foot-pound of energy is stored in it, yet if the above formula is used to calculate the same problem of the energy in a falling body, the books say that the mass must then be taken to be about one thirty-second of a pound.

It thus appears to the student that a mass of a pound is a pound except when it is used in that formula, as it then suddenly shrinks to about a thirty-second of a pound; and, to add to the confusion, a mass of a gram then shrinks to about a thousandth, leaving him to wonder why the same quantity of mass should shrink so much more when it happened to be weighed in grams instead of in pounds. And, still further adding to the confusion, text-books tell us that altho the proper units of mass are grams, pounds, etc., yet after introducing a numerical quantity of mass in this formula "it has no

unit"; for this crime of not being measurable in units it would lose its right to be called a physical quantity, even tho it is recognized to be one of the three fundamental ones! To apply all this instruction, parrot-like, to problems without understanding what one is doing may be satisfactory to some, but a conscientious engineer or student wants to understand what he is doing and why.

The fact is, there is nothing at all mysterious, and all the confusion would not exist, nor would the student waste brain energy in trying to understand it and would not hesitate to use masses in his calculations, if text-books always accompanied each formula with a statement of the units for which it will give the numerically correct result and the unit of the result. The blame for this confusion rests with the physicists who give us these valuable formulæ, but do not include the units and constants. Physicists are often satisfied with inserting in their formulæ the letter "f," which stands for "a function of," but engineers are not, and some say that this "f" sometimes stands for "a function of laziness of the physicist" in not working out the numerical value of it.

Pounds, grams, kilograms, etc., are perfectly proper units of mass, more so even than they are units of weight; and no other kinds of mass units are needed. Mass means the quantity of matter, and a gram of mass is always the same, whether on this earth, on the sun, or in universal space—which is not true of its weight. A gram or pound of mass, moreover, weighs exactly a gram or a pound at a particular part of the earth's surface and therefore may be used as a true and very convenient unit of force of one gram or one pound, and is so used in the terms gram-centimeter or foot-pounds; it takes exactly a gram or pound of a vertical force to support it; when these same forces move those masses up vertically thru a centimeter or foot, a gram-centimeter or a foot-pound of energy has been stored in it, tho these forces are not required to move them thru these distances horizontally, or in any direction in space removed from the earth's attraction.

Assuming gravity to be a constant, masses can be correctly expressed and measured in terms of their weights in grams or pounds, and the latter need not be divided by g to reduce them to masses, notwithstanding the statements in some text-books. It is true that when a force (or weight) is divided by an acceleration (g), the quotient correctly represents a mass, but the units in terms of which that mass is then expressed are then *not* the usual, well-recognized units of mass, and

therefore this method of expressing masses gives rise to a new, confusing, and entirely unnecessary set of mass units not now known nor having well-recognized names; and they involve g . The factors π and g are already troublesome enough in our units, then why unnecessarily add to this trouble? Surely it is better to cut them out, and wherever this is not possible or practicable, then at least to put them where they will cause the least confusion or trouble.

In the C. G. S. system, to which we naturally appeal for rescue in such cases of confusion, the unit of force, the dyne, is defined as that force which acting on a mass of one gram for one second will produce a velocity of one centimeter per second; this gram of mass is the same whether weighed on balances or hurled thru space.

The m in this formula correctly represents masses, pure and simple, without any modifications, new units, reductions, or apologies, and is not "merely a ratio." Any given number of grams, pounds, or kilograms of mass, expressed in the same number of grams, or kilograms of weight, may be directly and correctly substituted for m in these formulæ; that troublesome and unwelcome intruder g can safely be omitted and forgotten in that part of the calculation. A mass does not shrink on being inserted in a formula; there should be no two kinds of units of mass, one for definition and the other for use, one in theory and another in practice, one for a state of rest and another for a state of motion. In short, everything concerning the quantity of mass used in this formula is exactly the same as it is with any other physical quantity, hence there should be absolutely nothing about it to confuse the mind.

The confusion, which has existed for a century or more, lies entirely in the *incorrect interpretation of the results* obtained from these formulæ; that is, in the *units* in terms of which the result (energy) must be interpreted. For instance: 3 grams of mass—that is, a body weighing 3 grams—has a velocity of 4 centimeters per second; required to find the energy stored in it. Substituting these very figures, just as they are, in the well-known formula $mv^2/2$ gives 24 for the energy, which is correct. At first thought it would seem that as the given data are in grams, centimeters, and seconds, this result would be in gram-centimeters of energy; but this is not the case, and it is due to this, and only to this, misinterpretation of the result that the whole confusion arises. Energy is usually expressed as force $\times$ distance, hence in the unit gram-centimeter the gram physically represents a gram of force, while in the m it physically represents a gram of mass, and decidedly not a gram of force. The correct interpretation is that this energy, represented by 24, is in dyne-centimeters, called ergs, and not in gram-centimeters. It takes one dyne of force acting on one gram of mass for one second to give it a velocity of one centimeter per second, hence it will take $3 \times 4 = 12$ dynes acting for one second to give a mass of 3 grams a velocity of 4 cm./sec. The distance d in which a uniformly accel-

erated body started from rest attains a velocity of 4 cm./sec. is $d = vt/2$; hence if done in one second, as supposed above, $d = 4 \times \frac{1}{2} = 2$ cm. Therefore the energy is that of 12 dynes acting thru 2 cm., or 24 dyne-centimeters or ergs. This is equally true for any other number of seconds, as the product of the dynes and the centimeters is always 24.

To reduce this final result to gram-centimeters of energy, in order to make it correspond in terms with the grams (of mass) and centimeters in the given data, the resultant energy, 24 ergs, must be multiplied by the proper conversion factor, namely, one dyne-centimeter or erg = 0.00101979 gram-centimeter, giving 0.0245 gram-centimeter of energy as a second form of the answer. This is numerically the same result as would be obtained from the rules in the books, which say that the number of grams of mass measured as a weight must first be divided by g before it can be substituted for m in the formula. Three grams of mass divided by g (981) = 0.00306 of the "undefinable" units of the shrunken mass. This multiplied by $v^2/2 = 0.0245$ gram-centimeter, as before. This will be found to be equal to $24/g$, and mathematically it amounts to the same thing in this particular formula whether the mass or the resulting energy is divided by g .

Thus the statement in the books gives the correct result, but it is an awkward and irrational way of describing it, quite unnecessarily leaving the impression in the student's mind that the m in the formula is not the mass at all, but some undefinable, unitless quantity which is far smaller than the real mass. The fact that these statements have led to endless confusion, especially in the student's mind, concerning the way in which mass must be numerically expressed, while there is really no reason why there should be any confusion at all, is the best kind of proof that the usual way of stating it is not satisfactory. In fact, the statement that m does not really represent mass at all, but is a ratio and has no unit, is positively wrong; it is a true mass and can be correctly expressed in the formula in true grams, pounds, kilograms, etc.

Were it not for the fact that we can and do use the same terms, gram, pound, kilogram, etc., sometimes to represent units of mass and sometimes units of force—and it is quite correct to do so—no confusion would have arisen. When in the given data the mass is stated in grams and the velocities in centimeters per second, the natural supposition is that the resulting energy will be in gram-centimeters; or when in pounds of mass and feet, then in foot-pounds; or when in kilograms and meters, then in kilogram-meters. But this is not correct; in the given data these terms refer to quantities of mass, while in the results the same terms refer to forces. They may be correctly taken to amount to the same thing, in this formula and in the final energy, only when the force is that of the attraction of gravity, which is considered as a constant. The energy units in each case are different from the ones naturally expected, and

to reduce them to the latter requires a conversion factor, which in each of these cases is $1/g$, being careful to use the numerical value of g which corresponds to the velocity units.

The conclusions from the above are as follows:

Every formula should be accompanied by a statement not only of the units to be used in it but also of the unit in which the final result will be.

Quantities of mass may be correctly expressed by their weights in grams, pounds, kilograms, etc. (barring the slight differences of g in different places), and the results in substituting these weights directly (without first dividing by g) in the formula $mv^2/2$ for the energy in a moving body will then be as follows:

When the masses are expressed in grams (corresponding to their weights in grams) and the velocities in cm./sec. the resulting energies will be in ergs; to reduce the latter to gram-centimeters, multiply by 0.00101979 or divide by $980.597 = g$ in these units. Or $0.0005099 mv^2 = \text{gram-centimeters}$.

When the masses are expressed in pounds (mass or weight) and the velocities in ft./sec., the resulting energy will be in foot-poundals (a poundal being that force which acting on a mass of one pound for one second produces a velocity of one foot per second); to reduce this to foot-pounds, multiply by 0.0310832 or divide by $32.1717 = g$ in those units. Or $0.01554 mv^2 = \text{foot-pounds}$.

When the masses are expressed in kilograms (mass or weight) and the velocities in meters per second, the

resulting energy will be in an unnamed unit equal to ten million ergs (there appears to be no name for the force which acting on a mass of one kilogram for one second produces a velocity of one meter per second, but it is equal to a hundred thousand dynes); to reduce the figure thus obtained to kilogram-meters, multiply by 0.101979 or divide by $9.80597 = g$ in those units. Or $0.05099 mv^2 = \text{kilogram-meters}$.

Surely it is simpler for the student to understand that to convert these less familiar units of energy into the more familiar ones naturally requires a conversion factor than it is to understand and to justify the involved, confusing, and apparently contradictory explanations of the usual text-book method of dividing the mass (expressed in weights) by g in this particular case and not in others, especially when matters are made still worse by the addition of some quite false statements.

The first or direct results (in the absolute units dynes, poundals, etc.) are true anywhere in space, while the converted results (in grams or pounds of force), being based on terrestrial units, are true only on this earth and vary very slightly on different parts of it, except when the grams, pounds, etc., as *units of forces* are defined in terms of dynes or poundals (for a standard value of g), in which case they themselves also become absolute units; tho in that case a mass of a pound on a high mountain would not exert quite a pound of vertical force. In all of the above gravity is assumed to be a constant, as its variations are extremely small.

POTASH PRODUCTION INCREASING RAPIDLY

MORE potash has been produced during the first six months of 1917 than was made during the entire year 1916. The reports received by the United States Geological Survey, Department of the Interior, have been reduced to terms of the commercial unit commonly used to measure the available or water-soluble potash (K_2O) in the product, and only material actually sold by the producer during this period is included. The weight of the materials handled was therefore much greater than represented by these figures.

This table includes practically all potash produced.

The prices quoted range from \$3.50 to \$6 a unit, a unit meaning 1 per cent. of potash (K_2O) in a ton of the material as marketed—that is, a product carrying 25 per cent. K_2O may be sold at \$4 a unit, which would be \$100 a ton for the material marketed.

The figures given seem to indicate that the production

Summary of the Production of Potash in the United States, January to June (inclusive), 1917

Source	Available potash (K_2O) Short tons	Value at point of shipment
Natural salts or brines.....	7,749	\$2,808,240
Alunite and dust from cement mills and blast furnaces	1,867	746,576
Kelp	2,143	1,348,095
Distillery slop, wool washings, and miscel- laneous industrial wastes	2,153	876,714
Wood ashes	* 111	84,414
	14,023	5,864,039

* Only 25 reports of production from wood ashes have come in, some of the larger producers not having made returns.

for 1917 will exceed 25,000 tons of potash (K_2O), or two and one-half times that made in 1916. This is about 10 per cent. of the average normal yearly consumption of the country before the war, showing the need of further stimulating domestic production of potash.

EFFICIENCY WORK AS APPLIED TO CLERICAL FORCES*

JEAN G. ALLEN

THERE is more or less familiarity among engineers with efficiency work as applied to industrial establishments; that is, in machine shop, foundry, etc. The application of efficiency work to clerical forces is, however, comparatively new, as it has been carried on in the last five or six years only. Its application was begun by a large publishing company of Philadelphia.

The rising cost of labor and material has compelled the employer of a large clerical force to think, and to think seriously, about this work.

The industrial engineer having completed an investigation of a plant often finds he has a large clerical force (found necessary in order to maintain saving) the cost of which force is eating large holes in the saving he has made.

Some, no doubt, think that the possibility of standardizing the work of stenographers and clerks in offices is not practicable. This company, however, successfully standardized the work of stenographers, phonograph operators, bookkeepers, and general clerks, resulting in a net saving of thousands of dollars per year.

The principles of efficiency work being used in industrial establishments cannot be applied directly to a clerical force. It is generally conceded that the specialization of labor (*i.e.*, the assigning to each man of a small and definite task which he performs over and over again until he is expert at that particular job) means greater efficiency in the industrial plant. In clerical work, however, this is not found to be true, except in cases of very simple operations, such as enclosing circulars in envelopes, addressing by machine, stenographic and phonographic work, etc. In work of higher type the clerk, to understand fully the work and thereby avoid error, must have a knowledge of everything connected with the work he or she is doing. This is easiest accomplished by assigning all the work in connection with a certain job to one clerk.

As an example, I will take a recording section, which is a group of clerks doing the bookkeeping on agents' accounts. In addition to bookkeeping, there are various other operations to perform, such as sending out form postal cards, making out requisitions for copies to be shipped to the agent, notifying manager of bad accounts, etc. At one time this work was divided, with a separate and distinct group of clerks to handle each operation. The number of errors made under this arrangement caused considerable trouble, and a change was made. Each clerk was given the accounts of a certain number of agents and performed all the operations previously mentioned. As a result there was an immediate but small decrease in pro-

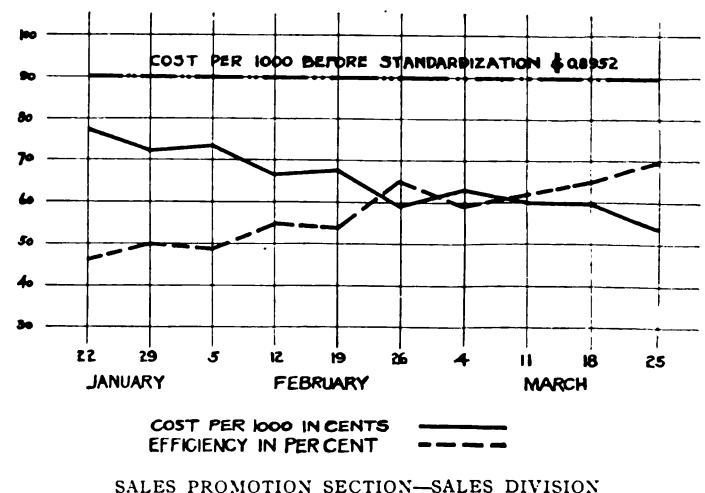
duction, but with a large decrease in the percentage of errors, more than making up for the decrease in production.

The above example shows that by specializing labor in clerical forces an increase of production can be secured, but in many cases errors are also greatly increased.

Before the engineer can hope to accomplish anything he must make a thoro study of the work and conditions surrounding it. If possible, he should be more familiar with it than anyone else. Changes are not made only at his suggestion, but because he can prove that the changes recommended will save money. A superior knowledge of the work makes the engineer's work easier, also, as he has the respect of both managers and employees.

When a thoro study of the work has been made, the next step is to establish cost and production records. Too much importance cannot be assigned to this part of the work. The civil engineer would not think of designing a floor beam without knowing what stresses and strains the beam was subject to, and likewise the efficiency engineer should not think of analyzing a department or section without knowing the costs of, and production made by, the department or section in question.

When the costs have been secured they can usually be divided under three general headings; *i.e.*, Material Cost, Equipment Cost, and Labor Cost.



In analyzing material and equipment costs two questions arise, which in general cover all conditions, as follows:

1. Is the material or equipment necessary?
2. Is the material or equipment the most economical that can be procured?

* Paper presented at Junior Meeting, April 23, 1917.

These questions are also applied to the labor cost, but the method of answering them is probably not quite so clear to the mind of the average layman as in the case of material and equipment.

A study of labor costs is divided into two divisions:

1. Standardization of method.
2. Standardization of product.

Not more than five per cent. of the clerks employed by the publishing company are capable of studying their own work in order to determine the best method of accomplishing it. Some clerks doing addressing work had their ink-wells so far from them, requiring to stretch to reach them. As these clerks were dipping their pens in ink about every thirty seconds, their arms were so tired by the middle of the day that the hourly production was considerably lowered.

The first thing to be determined in a study of methods is the necessity for doing the work. Can any or all of the work be dispensed with? In answering this question the engineer must be sure he considers the ultimate result. It is possible to make many immediate savings which would result in losses at a later date.

When the work which is necessary has been determined, motion studies should be made and a standard method for doing the work decided upon.

The standardization of product, or the process of determining the amount of work which should be done for a certain amount of money, is the next step. This is a very important part of the engineer's work, as a low standard means a money loss to the company and a high standard discourages the clerks and they will not do as much as they are capable of doing.

The publishing company uses the time-study method of setting a standard. A time study, to be of value, consists in personally making a study of some one clerk's work, and while so doing to use a stop-watch to note the time necessary to accomplish the work. By properly choosing the clerks to be "time-studied" the amount of work which a good clerk is capable of accomplishing can accurately be determined.

The average production made and personal observation of an operation are also of value in determining a standard. The exact method of setting a standard is so entirely dependent upon conditions affecting the operation that a separate and longer paper than this one would have to be written in order adequately to describe it.

When standards of work have been determined, the next problem is getting the clerks to increase their production to the point where they are producing the standard amount of work. This can be accomplished to a certain degree by a drive method; in other words, telling the clerks they must produce the standard amount of work. In using this method the supervision cost is high, the labor

turnover is increased, and the clerks are not coöperating with the manager, but are only working because they are afraid of him.

As an incentive for clerks to increase their production prize offers are made. These have proved most successful, in some cases doubling the production in a few weeks. A prize offer should always be generous, as an increase of 20 per cent. or 25 per cent. in production is not easily accomplished, and if the money return is not large enough clerks are apt to feel that the prize is not worth the effort.

Standards of production having been fixed, to hold the worker to this production, the generally accepted methods are the use of a bonus or piece-work plan. We are all familiar with the piece-work plan. The bonus plan consists in paying a salary for which you require a certain production. For any production made over this requirement a certain amount of money, called bonus, is paid. The bonus plan is the better of the two, as it assures the worker a definite sum of money each week or month.

The engineer, in determining a bonus or piece-work rate, should be assured the company will make a saving by the method proposed.

There is one argument the efficiency engineer has to answer more than any other. A manager will invariably contend that if the production is increased the number of errors will also be increased. This is not true. In every case where production has been increased in the publishing company, and when the unit of work was properly selected, the percentage of errors has decreased. The explanation of this is extremely simple. When a clerk is working at fifty per cent. of his capacity his mind is not on the work he is doing, and consequently he is liable to make errors. In maintaining a maximum production, however, his whole attention must be on the work at hand, with a consequent reduction in the number of errors made. A record of errors is a very important item when a plan is in effect to increase production. A money penalty imposed for each error will aid materially in reducing the number made.

The principles here given are shown very clearly in the foregoing chart. The straight line at the bottom shows the cost per thousand of production before any efficiency work was attempted. The solid line represents the cost per thousand after a bonus offer was put in effect. The dotted line is the efficiency—or measure of work produced—line, and it can be seen there is a slow but steady increase thruout the period the chart covers. A prize offer was started on February 21, and the effect of this is shown in the big decrease in cost for the week ending February 26.

Work of this kind, once started, cannot be left to run itself. A constant maintenance work must be done in revising standards, helping new employees, and setting standards for new work.

THE INFLUENCE OF THE WAR ON SUBMARINE POLICY*

By MARLEY F. HAY, Esq.

MEMBER OF SOC. N. A. AND M. E.

THE outbreak of war in August, 1914, found the supreme naval power, Great Britain, in possession of the numerically strongest submarine fleet. It comprised about 90 vessels, ranging, with a few experimental exceptions, from 200 to 800 tons in displacement.

The submarine at that time was admittedly and manifestly the weapon of the weaker power, inasmuch as it was presumably a weapon preëminently of defense, and it was hardly deemed politic for secondary or lesser powers to entertain aggressive national policies. Moreover, the tremendous pecuniary burdens involved in the acquisition and maintenance of a fleet of capital ships reduced this policy of defense to a policy of necessity. So conclusively is this the case that certain of the smaller powers have conceded the principle that, militarily speaking, submarines should form the major part of their fleet, with only a certain number of destroyers and auxiliaries as supports.

While the principle has been fully recognized in theory, a subtle but powerful consideration has tended to prevent its full implementation in practice; namely, the service or personnel necessity for large ships. An exclusively submarine navy would provide no sea commands for officers who had passed their thirtieth or thirty-fifth year, so that large ships have been incorporated in the fleet if for no other purpose than to provide higher commands for older officers and to offer sufficient incentive for young men to enter the naval service, without which prospect the ranks of the Naval Academy would have been hopelessly depleted. This has constituted the principal motivation for large ships in certain concrete instances. During the nineteenth century, Great Britain has occupied the position of supreme naval power, hence all other powers have been comparatively and relatively in the position of navally weaker powers. The logical result of this status should have caused the British Admiralty to discourage early efforts to establish the practicability of the submarine, and that the situation was thus appreciated is evidenced by the fact that Robert Fulton, the American inventor of an early type of submarine, was offered substantial remuneration by the Admiralty for the entire suppression of his patents and ideas. This occurred a century ago, after his failure to obtain recognition in America and France.

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In 1914 Great Britain's numerical superiority in submarines was probably attributable to a belief in the suitability of submarines for coast and harbor defense, which had in fact been amply demonstrated by their success in the naval maneuvers of the preceding five years. The utilization of submarines for coast and harbor defense naturally released a certain part of their fleet for other and possibly more important work.

In a consideration of the effect of the war upon submarine policy, we are immediately concerned with the principal belligerents, and especially the central empires, whose sea policy has brought submarines into such prominence.

On the allied side, France entered the world conflict with a heterogeneous assemblage of submarines, about fifty in number, with the widest range of variation, both in regard to displacement and military characteristics.

The Russian submarine flotilla has played a very inconspicuous rôle in the operations that have taken place hitherto, and can hardly be said to have influenced submarine policy, either technically or strategically. By and large, the same may be said of the other allied powers, and the comparatively late entrance of the United States as a belligerent, if nothing else, would account for the inactivity of American submarines, so far as the major naval operations in the North Sea and in the waters surrounding the British Isles are concerned.

It may fairly be assumed, however, that since April last this country has profited at least potentially by the previous war experience of the western allies. Paradoxical as it may seem in the light of later developments, the last of the great powers to admit the desirability of or necessity for submarines was Germany, and that conclusion was reached only under the pressure of actual war, when it was manifest that the rest of her fleet was of practically no use. If one believes that the German Government has been preparing for many years in anticipation of the present war, it seems incredible, in view of the completeness of her preparedness in all other respects, that the submarine arm of the naval service was neglected and discredited up to the day that war broke out. It was assuredly no oversight on the part of the German authorities, for in several conversations the writer had with Admiral von Tirpitz in 1911 in regard to Germany's submarine policy the latter expressed emphatically as his opinion that he considered submarines to be in an experimental stage, of doubtful utility, and that the German Government

was not at all convinced that they would form an essential or conspicuous part of its future naval programs. This opinion, which undoubtedly incorporated the opinion of his principal subordinates, was not expressed with any purpose of misleading, for it was a well-known fact at the time to every one in the profession that Germany's position in the matter of submarines was that of a third-class power.

When hostilities commenced Germany had twenty-five submarines in commission and was building perhaps half a dozen more. They were all of the Krupp-Germania type, and von Tirpitz explained almost apologetically that they had built a few just to be able to form some conclusions regarding them based on their own experience. It was evident at that time, however, that no great thought or attention was being devoted to their development, nor were ideas from outside sought.

Any casual student of European politics during the last fifteen years knows that in every international complication that arose and threatened European peace Germany was also to be found on one side and England on the other side as potential antagonists. If Germany had foreseen every contingency and provided for it in advance, she must necessarily have regarded the participation of England as an adversary in the present conflict, or, in fact, in any conflict in which Germany was involved, as a possibility at least, even if a remote one, and she must also have foreseen that the participation of England would bring about the enforced inactivity of the German high-sea fleet.

She could also have foreseen the situation that now prevails, *i.e.*, the submarine branch of her naval service would be the only one that could deliver any effective blows against England. Under these circumstances, how is it possible to explain the utter failure of the German Government to comprehend, or, if it comprehends, to provide for the rôle that submarines are playing to-day? Is it possible the General Staff and the Reichs Marine-amt refused to recognize the possibility of England's participation as even a remote contingency, and that no appropriate preparation was made to meet it? It would almost seem so, for when England definitely entered into the conflict against Germany steps were taken in feverish haste to lay down over sixty submarines at once, and that number has since been largely augmented.

Estimates have appeared in print according to which Germany was credited with having over 700 submarines in her possession last May and that 1200 would be in commission by the end of the year. It can hardly be possible that such an estimate has been made by any person familiar with the shipbuilding facilities of Germany, even making all due allowance for abnormal expansion of these facilities to meet the necessities of the occasion. It has been stated that drydocks would even be utilized for the purpose of erecting them, as if the problem were primarily one of ground space.

The entire shipbuilding capacity of Germany is very limited, compared with England, for instance, and the

difficulty of finding highly trained and skilled shipbuilding labor such as is required for the intricate work of constructing a submarine would militate heavily against any sudden increase in the tonnage that could be turned out. Taking into account all the shipbuilding facilities of Germany, both private and governmental, making the most liberal allowance for the maximum extension of these facilities under pressure of war, bearing in mind at the same time the difficulty experienced in obtaining certain necessary machinery and appliances and in obtaining skilled labor, and deducting the number of submarines that have probably been lost or destroyed by the enemy, it does not seem possible that Germany had more than 200 submarines in commission last May. Of this number approximately two-thirds would be constantly available for duty, while the other one-third would be *en route* either to or from the various shore bases for the replenishment of supplies and for repairs.

To arrive at a fair or accurate estimate of the rate at which Germany can build submarines in the future is somewhat more difficult. Assuming, however, that all yards in the country were utilized exclusively for this kind of work and that no mercantile shipbuilding or repairs to the battle fleet were undertaken, which, of course, is far from being the case, the probability is that not more than 100 submarines could be completed every six months.

Information at hand would indicate that the actual recent output has been approximately 10 per month, of which the great majority are in the neighborhood of 800 tons to 1000 tons displacement. Several groups of about 1500 tons have also been commissioned, and quite recently the construction of a flotilla of 8 so-called submarine cruisers of 2800 tons displacement has been undertaken of which 3 or more are reported completed and the remainder will be ready for service by next February. These vessels will mount two 6-inch guns, besides two guns of lighter caliber, and embody the innovation of an armored conning-tower. This is more or less essential where the conning-tower constitutes the central control station of the vessel and at the same time is the most vulnerable part. It is only feasible, however, on vessels of great size, because of submerged stability considerations.

All the later Austrian submarines have been manufactured in Fiume and Trieste from German plans and constitute, in effect, a German submarine flotilla in the Mediterranean that has avoided the necessity of the hazardous journey from the North Sea through the Straits of Gibraltar.

Turkey and Bulgaria have not been contributory factors in the submarine plan of campaign.

The effect of the war on the submarine policy of Germany has manifested itself in a tremendous program of acceleration and access of numerical strength, with increase in displacement and radius of action, as hereinbefore indicated, to meet the exigencies of long cruises off the west coast of the British Isles, necessitated by the effectual closure of the English Channel.

It is not at all clear that before the war any of the allied powers, or for that matter the central powers, seriously anticipated or contemplated the possibility of ruthless submarine tactics against merchant shipping as at present employed by Germany. Nevertheless, some years before the war there was a lively discussion in the British press of certain alarmist literature, notably a book by Sir A. Conan Doyle, in which ruthless submarine warfare at its worst against merchant and passenger vessels was portrayed with grim accuracy. It was generally, if uncomfortably, dismissed as grotesquely fantastic, with at the same time a secret hope that eventual enemies might fail to apprehend the pregnancy of the suggestion. The initiation of the sinking-on-sight policy was justified by its authors as another of those convenient "military necessities," the results of which would sanction its utilization.

That it was not a predetermined policy before the outbreak of war appears to be evidenced by the fact of Germany's complete unpreparedness at that time to conduct submarine warfare, coupled with the further fact that the design of the earlier German submarines indicated the intention of anti-warship rather than anti-merchantman tactics. Be that as it may, when the German submarine campaign was finally launched against the Allies in all its ferocity, academic questions regarding the presumptive policy of its inception had to give way to the physical fact of its reality and the necessity of counteracting it by every possible means. At a very early stage in the war, certain important areas were defended by a series of nets with various devices to indicate the presence of a submarine in the net and so aid in its capture or destruction. Large numbers of high-speed patrol launches mounting a 2-inch or 3-inch gun were employed to hunt and shoot down exposed conning-towers or hulls, and destroyers were rapidly fitted with emergency rams to permit them to charge submarines on sight with a fair chance of success without undue damage to themselves.

The immediate effect of these tactics on the part of the Allies produced the counter-measures of knife-edges and net cutters at the bow to facilitate penetration of the net, clearing lines and similar devices protecting all projecting parts to the same end, and housing periscopes to bring the top lenses in the housed position, below the clearing lines.

The larger submarines then under construction increased their armament to guns of 4-inch caliber to out-range the patrol boats, and the latest vessels with 6-inch guns are formidable opponents of a destroyer. The danger of ramming induced a radical increase in the length of the periscopes up to about 10 meters in some of the latest boats. By this means it is possible to keep a lookout in fairly rough weather with several feet of periscope exposed and at the same time maintain a sufficient depth of water above the vessel herself to practically preclude the possibility of successfully ramming. The conning-tower remains as the only vulnerable part in this condition, and the destruction of the tower, while serious enough, by no means entails the loss of the boat.

To reduce resistance to propulsion submerged and at the same time obtain sufficient rigidity in the free portion of periscope above the highest bearing, the use of the extremely long periscopes has necessitated an increase of the housing distance to the greatest practicable degree, the eye-piece in some cases being almost in the bottom of the boat when the periscope is fully housed.

The ubiquity of vigilant patrols and destroyers, frequently making no invidious distinctions between friend and foe, has necessitated on both sides a revised conception of quick transition from the surface condition to the submerged condition, whether statically or dynamically. The necessary sequence of operations to bring about this transition, which in time of peace were customarily performed consecutively, are now perforce executed simultaneously, and any practical expedient by which seconds may be saved is unhesitatingly adopted. Upon a given signal the engines are stopped, exhaust pipes closed, clutch to main shaft disengaged, conning-tower hatch closed, ventilators closed down, motors started, kingston valves and vents for flooding main ballast tanks opened, and the crew all stand by at battle stations.

To still further expedite this maneuver, the allied submarines navigate frequently with open kingstons, depending upon air-pressure in the ballast tanks to regulate the ingress of water. The Germans, on the other hand, maintain a partial vacuum in the empty ballast tanks, which in effect approximately doubles the head of water. As the tanks must, in the nature of the case, be filled while the vessel is still on the surface, the head of water can never exceed the draught of the vessel, and even this comparatively low head is steadily reduced by the filling of the tank. With a given total area of kingston valves, the increased rapidity with which the water will flood a tank containing a partial vacuum instead of air at atmospheric pressure will be apparent. The usual vent pipes to permit the escape of air from the tanks are also fitted, and these are opened as soon as the vacuum gauge on the tanks indicates the reestablishment of atmospheric pressure. The partial vacuum in the tanks is obtained by pumping out the air with the usual high-pressure air compressors that are installed for air service purposes.

The system is open to the objection that an emergency might arise demanding quick submergence shortly after a previous emergence and, before sufficient time has elapsed, to produce underpressure in the tanks. As the time required is comparatively short, however, and even a few inches of vacuum are effective in increasing the rapidity of flow, this disadvantage is relatively insignificant.

At an early stage it was apparent to the German authorities that the expenditure of 20-inch or 18-inch torpedoes on merchant ships represented wasted energy; moreover, the number of tubes and torpedoes of that size that a vessel could carry was relatively limited. At the same time, the general policy of defensively arming merchant ships militated against the German practice of coming to the surface and leisurely sinking the victim with a

few inexpensive bombs placed on board or several well-directed shots from the guns, for which two to three hundred rounds of ammunition could be stowed.

These considerations, taken in conjunction, indicated the desirability of evolving a new type of small torpedo proportionate to the work to be done, of which a larger number could be carried on board than would be possible with 18-inch or 20-inch torpedoes within equal limitations of weight and space. This led to the adoption of the 14-inch torpedo and permitted the installation of approximately twice as many tubes and torpedoes in a given design.

The experience of the war has taught submarine officers to make the most of the virtue of invisibility: showing more than the top of a periscope during the twenty hours of daylight in the summer months is an undue risk not to be taken without sufficient reason. The energy of the battery must be conserved, however, to be available when needed in an emergency. To that end, arrangements have been perfected to facilitate what is variously known as balancing, statical diving, or suspending. With a minimum expenditure of power, the vessel remains stationary in the submerged condition, with only the tops of the fully extended periscopes exposed. With the sensitive listening devices now extant it is of vital importance that this mechanism be as nearly noiseless as possible and that no air-bubbles escape to betray the presence of the boat. By housing the periscopes during this maneuver, nothing is visible above the surface of the water.

It is sometimes employed when close pressed to elude pursuit when the depth of water is too great to permit descent to the bottom.

Another method of economizing battery energy frequently resorted to consists in navigating the vessel with the ballast tanks full and ready for diving under the Diesel engine. The only exposed portion in this condition is the conning-tower fairwater, and that is not a measure of the actual reserve buoyancy, for the apparent freeboard is due to the dynamic effect of propelling the vessel forward in this condition with the stern diving rudders set slightly to rise. The hatches all being closed, the air for the engine is supplied by a quick-closing ventilator.

This operation was regarded dubiously before the war, but its success has justified its wide adoption, so that what was once considered a precarious expedient has now become commonplace routine. Doubts were felt regarding the possible effect on the crew of a sudden inadvertent closure of the ventilator supplying air to the engines and a consequent rapid drop in internal pressure. In practice the effect on the crew is *nil*, other than a momentarily disagreeable numb sensation in the ear-drums.

The use of nets in this war as a defense against submarines and the desirability of evading these entanglements by diving below them will probably lead in course of time, if it has not already done so, to the consideration of increasing the strength of the pressure hull to make submergence to a depth of 300 or 400 feet a practical

possibility, instead of the working limit of 200 feet that generally obtains to-day. To accomplish this result a certain rather serious sacrifice of other military qualities will be, of course, inevitable.

During the first years of the war little success was experienced in combating submarines with submarines principally for the reason that their reciprocal invisibility militated against their finding each other except when one was on the surface. Later developments in submarine signalling and sound-detecting devices have made it possible, however, to hear a submarine even when it cannot be seen, and also to approximate its direction. That being the case, it is quite conceivable that a numerous flotilla of submarines submerged statically in suspected areas with only the periscope objective exposed might lie in wait until the sound of the enemy's propellers or the hum of the electric motors became audible. In all probability the sound of the propellers would be heard first and the comparatively high rotative speed should distinguish it from the propellers of an ordinary vessel. In any case a look thru the periscope would resolve any doubt on the subject.

Proceeding in the direction whence the sound came, an effort would be made to locate the enemy's periscopes and get within torpedo range. Any submarines now in commission provided with the latest listening plates could perform the function of a submarine patrol with a certain degree of success, but it is evident that a submarine designed especially for this kind of work—in short, a contra-submarine—would logically depart considerably from the characteristics of submarines proper as we now know them.

The evolution of a radically different type would involve for every nation the creation of a flotilla of contra-submarines to oppose the submarines the enemy would send against her. It is, of course, possible to make a compromise design combining the essential characteristics of the submarine-*versus*-warship type with the submarine-*versus*-submarine type, but such a compromise is not compatible with the highest requirements of either and is likely to entail the weak points of both and the preëminent advantages of neither.

For that reason two distinct and separate types are to be preferred.

The contra-submarine will do practically all of her work submerged. Therefore the displacement should be sufficient to ensure satisfactory habitability, and a very powerful battery and large motor should be installed to give the maximum possible endurance submerged and the highest submerged speed at the maximum discharge rate of the battery.

On the other hand, battery efficiency expressed in output per pound of weight is highest when the individual cells are not too large, especially when the vertical measurement is at a minimum, nor is it desirable to unduly increase the voltage. Hence practical limitations are imposed which will possibly determine 500 to 600 tons as a satisfactory surface displacement.

Facility of maneuvering submerged also inhibits too great a displacement.

Everything that contributes to resistance submerged should be examined critically with a view to reduction or elimination. The conning-tower and periscope complex adds about 35 per cent. to the total resistance, out of all proportion to its relative size. The periscopes naturally cannot be omitted, but a large reduction in resistance may be effected by restricting the function of the conning-tower to that of a simple entrance hatch to permit ingress and egress in heavy weather and reducing its section to the "irreducible minimum." If made of nonpressure-tight construction, it could be of elliptical section and still further reduce its eddy-making propensities.

In certain French submarines built before the war the idea of reducing resistance submerged was carried to the extent of eliminating the conning-tower altogether and fitting in its place a canvas weathercloth to protect the entrance hatch in heavy weather. Thus the boat was virtually destitute of an entrance hatch that could be safely opened when seas were breaking continuously over the deck. After a few disagreeable experiences the practice was discontinued. There is no good reason, however, why the conning-tower, or, properly speaking, the entrance hatch in this special case, should not be made housing to be elevated only when weather conditions require it.

Docking keels, bilge keels, and other power-consuming hull appendages should be dispensed with, to the limit of absolute indispensability.

As for armament, the same process of logical reasoning that induced Germany to adopt 14-inch torpedoes would obtain in this case, altho the writer believes that still smaller torpedoes, say of 12-inch diameter, would be preferable.

In stalking an enemy submarine, it is not likely that more than one opportunity to fire at point-blank range would be presented, and with the extremely long periscopes now in use there is no means of ascertaining whether the enemy whose periscope is sighted is 8 feet or 20 feet or more below the surface.

With housing periscopes adapted to be used in practically any position, the length of exposed portion of periscope no longer indicates the depth of the boat, so the possibility of a torpedo going over or under the target due to this uncertainty is considerable.

To reduce the influence of this disability to a mini-

mum, as many tubes as possible should be grouped for simultaneous firing, arranged at slightly divergent angles, with torpedoes set for various depths, so that dispersed fire is obtained on the principle of a shot-gun.

Such a group of tubes can more readily be fitted in the bow than elsewhere. It is important, however, that the contra-submarine should have as great an arc of fire as possible with the minimum necessity for training the boat in azimuth, for which reason a battery of perhaps four stern tubes could be installed. Broadside tubes do not lend themselves readily to this arrangement, especially as each group could only be fired on one side. This consideration, together with the difficulty of firing from bow tubes at point-blank range in a vessel of large displacement, constitutes another argument against unduly increasing the displacement of these vessels.

They should, of course, be self-sustaining, therefore equipped with Diesel engines to charge the batteries in not over four hours. Therein lies their greatest vulnerability, altho in that respect they are in a similar case with any other type of submarine. During the period of battery charging at night, they must not only come to the surface and sacrifice the immunity of invisibility, but the noise of the Diesel engine exhaust is distinctly audible for a long distance and characteristic in its quality. If the exhaust be arranged above the water-line, it is directly audible. If an under-water exhaust be employed, the microphone of the listening plate on another vessel tells the story. From the two horns of that dilemma there appears to be no immediate escape, but it offers a promising field for ingenuity.

In stalking enemy submarines, either in the open or using a merchant ship as decoy, the element of chance naturally plays a conspicuous part. At least as much success will probably be attained when no decoy ship is used, for the reason that the noise of the decoy's propellers will tend to obliterate the sound of the enemy's screws. An extensive zone of silence as complete as possible is really the desideratum, and all internal noise must be entirely eliminated. Under these conditions a sufficiently numerous fleet of submarine patrols in the theatre of operations would assuredly serve to cause the enemy some distraction other than the preoccupation of hunting down merchant ships, and this fact alone, not to mention its undoubted undermining effect on the enemy's morale, would justify its *raison d'être*.

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JOHN D. CASSELL (A. S. H. & V. E.)
H. F. SANVILLE (A. I. E. E.)

PAPERS

LEWIS H. KENNEY, Chairman
R. H. FERNALD
W. POOL PARKER
H. P. GANT
G. M. SPEAR
W. M. BOEHM
H. F. SANVILLE
L. P. KELLOGG
J. A. STEINMETZ

MEMBERSHIP

D. ROBT. YARNALL, Chairman
H. GOODWIN, JR.
A. W. BARTLETT
R. H. FERNALD
A. C. WOOD

TELLERS

GEO. E. CROFOOT, Chairman
JOHN P. MUDD
HAROLD GOODWIN, JR.
CHAS. F. PUFF
JOHN S. ELY

BY-LAWS

J. F. STEVENS, Chairman
J. C. TRAUTWINE, JR.
GEO. W. BARR
ROBT. M. BARR

SPECIAL COMMITTEES

NATIONAL SERVICE

GUILLIAEM AERTSEN, Chairman
LEWIS H. KENNEY
WM. C. L. EGLIN
S. M. SWAAB
J. F. STEVENS
F. K. WORLEY

INCREASE OF MEMBERSHIP

CLAYTON W. PIKE, Chairman
CHARLES E. BONINE
F. H. GILPIN
FREDERICK J. RYAN
W. P. DALLETT
J. D. CASSELL
H. A. TERRELL
J. E. GIBSON
CHARLES F. MEBUS
T. Y. OLSEN

AFFILIATED SOCIETIES

CARL HERING, Chairman
D. KNICKERBACKER BOYD
HARLAN S. MINER
D. ROBERT YARNALL

BUILDING

F. C. DUNLAP, Chairman
S. M. SWAAB
H. P. GANT
J. F. MURRAY
WM. POOL PARKER
H. A. STOCKLY, Sec'y of Comm.

SECRETARY TO THE SECRETARY

S. M. SNEDEKER

COMMITTEE ON PAPERS

LEWIS H. KENNEY, CHAIRMAN



SPECIAL MEETING

**Joint Meeting with the Manufacturers' Club at its
Club House, Monday, December 10, 1917, 8.15 P. M.**

**Captain W. Strother Smith, U. S. N., will present an address on "Inventions
Relative to War Material."**

Captain Smith will speak of the application of inventions, enlisting the services of engineers in presenting inventions, reducing inventions to practical engineering conditions, comparison of engineering talent thruout the world and the needs of the Navy. the relation between the engineer and the manufacturer, and the link between the manufacturers and the needs of the Navy. The Captain will relate some of his experiences with inventions since he has been on duty at the Navy Department.

MEETING FOR JUNIOR MEMBERS

**Tuesday, December 11, 1917.—Meeting at the Engineers' Club. The following paper will be presented:
"Measurement of Flow of Fluids and Gases in Pipes." By Lester M. Goldsmith.**

REGULAR MEETING

At Witherspoon Hall, Wednesday, December 19, 1917, 8.15 P. M.

The address of the evening will be made by **Mr. G. Douglas Wardrop**, Editor, *Aerial Age Weekly*, on **"The War in the Air."**

The paper will be illustrated with lantern slides and motion pictures.

Members of Affiliated Societies are cordially invited to attend.

Members of the Club and Affiliated Societies are privileged to invite ladies.

Mr. Wardrop will speak of wireless coöperation with artillery, reconnaissance, bomb dropping, night flying, aerial photography, military aerostatics, naval aeronautics and other phases of the subject.



The Worcester Tech Club invites the members of the Engineers' Club to attend its meeting, January 3, 1918. (See detailed announcement on Page 598.)

CALENDAR OF REGULAR MEETINGS

THE ENGINEERS' CLUB AND AFFILIATED SOCIETIES

1917-1918

DAY OF MONTH AND WEEK	NAME OF SOCIETY
First Monday	American Society of Civil Engineers January 7, April 1.
Second Monday	American Institute of Electrical Engineers December 10, January 14, February 11, March 11, April 8, May 13, June 10.
Fourth Monday	Philadelphia Safety Council January 15, February 25, March 25, April 22, May 27, June 24.
Second Tuesday	Engineers' Club (Junior Meeting) December 11, January 8, February 12, March 12, April 9.
Third Tuesday	Engineers' Club (except December, January and February) March 19, April 16, May 21, June 18.
Fourth Tuesday	American Society of Mechanical Engineers December 11, January 22, February 26, March 26, April 23, May 28, June 25.
First Wednesday	Technology Club December 5, January 2, February 4, March 6, April 3, May 1, June 5.
Third Wednesday	Engineers' Club (December and January) December 19, January 16.
First Thursday	Worcester Tech Club December 6, January 3, February 7, March 7, April 4, May 2, June 6.
Second Thursday	American Society of Heating and Ventilating Engineers December 13, January 10, February 14, March 14, April 11, May 9, June 13.
Fourth Thursday	Society of Automotive Engineers January 24, February 28, March 28, April 25, May 23, June 27.
Third Friday	Engineers' Club (February) February 15.
Third Friday	Illuminating Engineering Society December 21, January 18, February 15, March 15, April 19, May 17, June 21.

Engineers' Club Meetings at Witherspoon Hall will be as follows:

Wednesday, December 19, **Engineers' Club Meeting.**
 Wednesday, January 16, **Engineers' Club Meeting.**
 Friday, February 15, **Engineers' Club Meeting.**

Members of all Affiliated Societies are invited to these meetings.

SCHEDULE OF MEETINGS

THE ENGINEERS' CLUB AND AFFILIATED SOCIETIES

DECEMBER, 1917

Wednesday, December 5, 1917	Technology Club of Philadelphia Subject: "The Year's Work of the Advisory Commission of the Council of National Defense" Dr. Hollis Godfrey	Engineers' Club	8.15 P.M.
Thursday, December 6, 1917	Worcester Tech Club Paper: "Modern Foundry Machinery" Mr. Ambrose G. Warren	Engineers' Club	8.15 P.M.
Monday, December 10, 1917	Joint Meeting Engineers' and Manufacturers' Clubs Address: "Inventions Relative to War Material" Captain W. Strother Smith, U. S. N.	Manufacturers' Club	8.15 P.M.
Monday, December 10, 1917	American Institute of Electrical Engineers Paper: "Electricity and Conduit Construction" Mr. H. C. Blackwell Also short paper: "Annual Load Relief Map, Peak Load and Load Factor Analysis" Mr. W. L. Robertson	Engineers' Club	8.00 P.M.
Tuesday, December 11, 1917	Junior Meeting Paper: "Measurement of Flow of Fluids and Gases in Pipes" Mr. L. M. Goldsmith	Engineers' Club	8.15 P.M.
Tuesday, December 11, 1917	Joint Meeting American Society of Mechanical Engineers and Franklin Institute Paper: "Offensive Against the Submarine" Mr. J. A. Steinmetz	Franklin Institute	8.15 P.M.
Thursday, December 13, 1917	American Society of Heating and Ventilating Engineers Subject: "Modern Heating and Ventilating Appliances for School Buildings"	Engineers' Club	8.15 P.M.
Wednesday, December 19, 1917	Regular Meeting Engineers' Club Address: "The War in the Air" Mr. G. Douglas Wardrop	Witherspoon Hall	8.15 P.M.
Friday, December 21, 1917	Illuminating Engineering Society Paper: "Color in Illumination" Miss Beatrice Irwin	Franklin Institute	8.15 P.M.

SECRETARY'S NOTICES

A BUSINESS MEETING of the Club, to consider the following addition to the By-Laws, providing for Life Membership, will be held at Witherspoon Hall on Wednesday, December 19th, 8.15 P. M.:

Article VII

Section 9. "An Active Member in good standing may become an Active Life Member by a single payment to the Club of the sum of \$300, and shall thereafter enjoy all the rights and privileges of an Active Member and become exempt from all future payments or assessments, provided, however, that there shall not be at any one time more than 100 Active Life Members."

H. A. STOCKLY, *Secretary*.

ABSTRACT OF MINUTES OF THE SPECIAL MEETING OF THE CLUB

HELD FRIDAY EVENING, NOVEMBER 9, 1917

The meeting was called to order by Vice-President Yarnall at 8.15 P.M., at the Museum of the University of Pennsylvania. The use of the Museum was extended to the Club thru the courtesy of Dr. William Curtis Farabee, who presented an illustrated address on "Explorations Among the Wild Tribes of South America."

At the close of the lecture, those present were invited by Doctor Farabee to view the many specimens and trophies collected by him on his explorations.

A unanimous vote of thanks was extended Doctor Farabee for his most interesting address and the privilege of viewing his specimens.

ABSTRACT OF MINUTES OF THE BUSINESS MEETING OF THE CLUB

HELD TUESDAY EVENING, NOVEMBER 20, 1917

The meeting was called to order by President Vogleson at 8.15 P.M., at Witherspoon Hall. About 500 members and guests were in attendance.

The minutes of the Regular Meeting of October 16, as printed in the JOURNAL, were approved.

The personnel of the Committee on Nominations, as submitted by the Board of Directors at the October meeting of the Club, was accepted.

Announcement was made of the election of ten applicants for Active Membership.

The paper of the evening, entitled "Engineering and Construction Features of Cantonments," was presented by Major Richard C. Marshall, Jr., U.S.A.

A unanimous vote of thanks was extended to Major Marshall.

The meeting adjourned at 9.45 P.M.

ABSTRACT OF MINUTES OF REGULAR MEETING OF THE BOARD OF DIRECTORS

NOVEMBER 13, 1917

The meeting was called to order at 7.15 P.M., with President Vogleson, Vice-Presidents Yarnall and An-

draws, Directors Fernald, Henderson, Joseph C. Wagner, Kenney, Moody, Forstall, Robert M. Barr, Past Presidents Swaab, Ledoux and Carter, Treasurer Stevens, and Secretary Stockly in attendance. Vice-President Eglin, Directors Hayward, Samuel T. Wagner, Ehle and George W. Barr were excused. Director Bullens was absent.

The minutes of the Regular Meeting of October 9, as submitted to the Board, were approved.

REPORT OF THE PRESIDENT

Major Andrews, of the 103d Regiment Engineers, stationed at Camp Hancock, stated that a recent reorganization of the divisions made available several bands, one of which was to be assigned to his regiment. He therefore suggested that the funds being raised by the Club for the purchase of band instruments be used for the purchase of 500 Christmas boxes instead, to be sent to the members of the regiment who formerly constituted Companies B and E, Pennsylvania Engineers. By this arrangement each member of the regiment will receive a Christmas box, the remaining companies being similarly cared for by their friends in Scranton and Pottsville.

The Committee on National Service was requested to use the funds obtained for the band for the purpose set forth by Major Andrews.

Mr. J. Franklin Stevens has been appointed a member of the Committee on Finance.

Mr. D. Robert Yarnall has been appointed a member of the Committee on Affiliated Societies.

Mr. A. C. Wood has been appointed a member of the Committee on Membership.

Mr. F. K. Worley has been appointed a member of the Committee on National Service.

Mr. J. W. Ledoux has been appointed a member of the Committee on Public Relations, *vice* Dr. Edgar Marburg, resigned.

As the chairmen of the Committees on Finance and House are not at present members of the Board, the resolution adopted by the Board June 5, 1917, was amended to authorize, "The President to appoint an Executive Committee and fill vacancies that may occur therein from time to time."

ENGINEERS' CLUB OF PHILADELPHIA

Messrs. Thomas C. McBride and Emmett B. Carter were appointed to represent the Club at the New York meeting of the American Society of Mechanical Engineers, December 7.

The resignation of Mr. Swaab as chairman of the Building Committee was presented and left in the hands of the President, who, with the understanding that Mr. Swaab would remain a member of the Committee, accepted the resignation with regret, and appointed Mr. C. F. Dunlap chairman.

REPORT OF THE SECRETARY

Resignations from the following members in good standing were accepted as of March 31, 1918:

William L. Austin	W. S. Jones
C. L. Borie, Jr.	John A. Kelley
Frank B. Bower	H. J. Kleinman
J. W. Brinton	J. I. Kyle
David P. Chabrow	S. J. Levine
Edward S. Clinch, Jr.	G. G. Mankey
W. P. Cochran	R. F. Moon
Charles C. Davis	E. L. Nash
S. Horace Disston	Harold Pender
Charles A. Flanagan	S. Howard Pennell
Donald Flanigan	J. Livingston Poultney
Herbert W. Geschwind	N. H. Schwenk
John E. Gillmor	Harry F. Sieber
J. S. Goldbaum	Clarence E. Wunder
Roger Granger	Louis S. Zislin
A. W. Herbst	

The resignation of Mr. J. G. Hart'ey, Active Member, tendered February 2, 1917, was accepted as of March 31, 1917.

Mr. Stacy B. Opdyke, Active Member, died on October 25, 1917.

REPORT OF THE TREASURER

The Treasurer submitted a report covering bank balances, which was accepted.

REPORT OF THE COMMITTEE ON FINANCE

The Committee reported the following actions taken at its meeting on November 1:

"That the Committee on Finance authorize the Building Committee to expend at this time \$15,500 in carrying out main-floor alterations, together with all necessary equipment."

"That it would be highly desirable to complete at the earliest possible moment the main-floor alterations in their entirety, together with all necessary furnishings."

The report was accepted, and it was further resolved that a special meeting of the Board be called not later than two weeks from this date, at which time the extent and nature of the alterations to the Clubhouse to be made at this time would be determined.

REPORT OF THE COMMITTEE ON HOUSE

The Committee's report that, in connection with the national conservation of food, several suggestions of the

United States Food Administration were put into effect in the Club restaurant, was approved.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The following were elected to *Active* Membership:

Carroll Beale	Edwin C. Huber
Theodore T. Burchfield	Richard I. Motysek
Ronald G. Coolbaugh	William J. Murphy
Edmund deF. Curtis	Charles E. O'Halloran
George H. Dickel, Jr.	Victor L. Sanderson

REPORT OF THE COMMITTEE ON PUBLICATION

The Committee presented a financial statement, showing as of November 1, 1917, an unexpended balance of \$1474.71 in its appropriation.

REPORT OF THE COMMITTEE ON PAPERS

Announcement was made of two special meetings, to be held in November and December, respectively, arranged in accordance with authority granted by the Board at its October 9 meeting.

REPORTS OF SPECIAL COMMITTEES

Committee on Public Relations

The Committee reported that, in view of the fact that no important matters had been brought to its attention, no meeting had been called during the previous month.

Committee on National Service

The Committee reported that a letter had been issued to the membership, requesting contributions of one dollar from each member toward the purchase of band instruments for the 103d Regiment Engineers, now at Camp Hancock.

Committee on Increase of Affiliated Societies

The application for affiliation of the Local Section of the Philadelphia Safety Council was presented by the Committee.

The members of the Board present all voted in favor of the affiliation. The total vote, however, not constituting two-thirds of the Board, which is a requirement of the By-Laws, it was ordered that a letter ballot be taken of the members of the Board not present.

Building Committee

The Committee reported progress in the work of alterations.

NEW BUSINESS

The question of changing the meeting hour of the Board from 6.15 P.M. to 4 P.M. was discussed, and it was decided to call the next meeting of the Board, which is to be a special meeting, two weeks from this date, at 4 P.M., at which time the matter would be taken up further.

The meeting adjourned at 9.30 P.M.

H. A. STOCKLY,
Secretary.



THE ENGINEERS' CLUB IS PLEDGED TO SUPPORT THE UNITED STATES FOOD ADMINISTRATION

We are not urged actually to eat less, but to eat without waste, and to conserve the concentrated foods, **WHEAT, FATS, SUGAR AND MEATS** (exclusive of poultry and game),

FOR

THE SOLDIERS AT THE FRONT NEED THEM ALL

THE supplies in the world's larder for the next twelve months are now known. *They are too short to support our Allies unless every man, woman, and child enters national service to support the Food Administration.*

Our Allies have rigidly enforced economy in consumption and elimination of waste, but soldiers and war workers, including millions of women now in physical labor, require a larger quantity of food than in the past. Therefore, any food shortage will fall mostly upon the non-war working class, mostly old people, women, and children, so that any failure of ours means more privation to them.

The food animals among the Allies have decreased since the war began by about 33,000,000 head, thus their meat, fat, milk and butter have decreased in the face of increased need.

We must send more meat, condensed milk, butter and cheese and more pork products, although our animal products are but little larger than before the war.

France and Italy formerly produced their own sugar. They cannot do so now. England imported largely from Germany and Russia. Therefore, our Allies must now come to the West Indies for over 2,000,000 tons if they are to obtain a normal amount. They thus draw from our own source of supply and we must divide with them.

Of potatoes and other vegetables we have a superabundance which we cannot ship because they require from four to ten times the tonnage of more concentrated foods. We have abundant fish, sea foods, and poultry.

Therefore, we have two clear duties: First, to substitute other commodities we have in abundance for those that we can ship; second, to eliminate every waste. If in this way we can reduce our average consumption per person, 1 pound of wheat flour, 2 ounces of fat, 7 ounces of sugar, and 7 ounces of meat per week, and if we use our milk and butter carefully and without waste, we can maintain our own people on a full diet and can still supply the deficiency in our Allies' food, for when these apparently small individual savings are multiplied by 100,000,000 every week, they assume gigantic proportions and offer a complete solution of our problem.

We must remember that every flag that flies against

Germany is by proxy the American flag; that those fighting in our defense cannot be maintained over this winter without the minimum food necessary for their armies and ours, and for their men, women, and children at home. The provision of these needs can be accomplished only by the resolute personal service of every man, woman, and child in this country. This is your individual service in this war. We ask the public to support you in this plan by eating plenty, but eating wisely and without waste, for every ounce wasted is a contribution to starvation.

GENERAL PLAN

Our problem

is to feed our Allies this winter by sending them as much food as we can of the most concentrated nutritive value in the least shipping space. These foods are wheat, beef, pork, dairy products, and sugar.

Our solution

is to eat less of these and more of other foods of which we have an abundance, and to waste less of all foods.

We are urged to use more chicken, fish, hare, rabbit, duck, goose, lobster, oysters, clams, sea foods, eggs and vegetables and to use less beef, mutton, pork, sugar, milk and cream.

The following is a "Beefless Tuesday" menu:

Tuesday, November Twenty

THE ENGINEERS' CLUB OF PHILADELPHIA CLUB DINNERS

No. 1—75c.

Oysters or Fruit in Season
Soup of the Day
Meat of the Day
Two Vegetables
Dessert
Coffee, Tea, Etc.

No. 2—75c.

Soup of the Day
Meat of the Day
Two Vegetables
Salad
Dessert
Coffee, Tea, Etc.

No. 3—60c.

Soup of the Day	Meat of the Day	Two Vegetables
Dessert		Coffee, Tea, Etc.
SOUPS		
Clam Chowder		Chicken Okra
MEATS		
Fried Smelts	Tartar Sauce	Roast Chicken, Stuffed
VEGETABLES		
Lima Beans		Mashed Potatoes
DESSERTS		
Apple Pie	Rice Pudding	Baked Apple
Pineapple Ice Cream		Strawberry Ice Cream

COMMITTEE ON MEMBERSHIP

D. ROBERT YARNALL, CHAIRMAN

CANDIDATES FOR MEMBERSHIP

Members having knowledge of the candidates are invited to submit to the Committee on Membership before December 10 a confidential expression of opinion as to the eligibility of the candidates; all communications to be addressed, "Chairman of the Committee on Membership, Engineers' Club, Philadelphia," marked "Confidential."

All applications are on file at the Club and can be referred to by any member.

FOR ELECTION TO ACTIVE MEMBERSHIP

CRAIG ADAIR

Care of Penn. Seaboard Steel Corporation, Franklin Bank Building, Philadelphia, Pa.
Assistant to President, Penn. Seaboard Steel Corporation.
Proposed by F. B. O'Connor, James Monroe, and St. John Chilton.

CLAUDE AUGUSTUS BULKELEY

Room 863, duPont Building, Wilmington, Del.
Engineer, E. I. duPont, deNemours & Co.
Proposed by H. P. Gant and A. Thornton Lewis.

ARTHUR C. FREEMAN

Seventieth Avenue and Twelfth Street, Oak Lane, Philadelphia, Pa.
Resident Engineer, Emergency Fleet Corporation.
Proposed by Henry C. Adams, Jr., and J. M. Winston.

EUGENE T. HUNT

1025 Widener Building, Philadelphia, Pa.
Manager, Philadelphia Office, Cyclone Fence Company.
Proposed by T. B. Preston and Robert M. Barr.

MANLY J. MILLER

739 South Fifty-seventh Street, Philadelphia, Pa.
District Sales Manager, Diamond Power Specialty Company.
Proposed by Daniel C. Reynolds and James S. Kunkle.

ALBERT F. NOBLE

603 Finance Building, Philadelphia, Pa.
Factory Sales Representative, Thomson Electric Welding Company, Lynn, Mass.
Proposed by M. A. Sherritt and H. Goodwin, Jr.

VICTOR N. WELAMB

1605 Sansom Street, Philadelphia, Pa.
Manager, Baker, Smith & Company.
Proposed by Lee Nusbaum and Elias Nusbaum.

FREDERICK J. WILKES

5348 James Street, Philadelphia, Pa.
Owner Frankford Machine Works.
Proposed by T. B. Preston and Robert M. Barr.

RICHARD F. WILLIAMS

1141 South Sixtieth Street, Philadelphia, Pa.
Sales Engineer, Sherritt & Stoer Company, Inc.
Proposed by M. A. Sherritt and H. Goodwin, Jr.

FOR ELECTION TO JUNIOR MEMBERSHIP

ALFRED AARON ADLER

2009 North Park Avenue, Philadelphia, Pa.
Test Engineer, American Engineering Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

CHARLES STUART BALLANTINE

4810 Germantown Avenue, Philadelphia, Pa.
Radio Engineer.
Proposed by W. M. Boehm and Lewis H. Kenney.

ARTHUR A. BLUE

512 West Coulter Street, Philadelphia, Pa.
Metallurgist, Midvale Steel Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

MAURICE JACOB CANTER

1914 North Thirty-first Street, Philadelphia, Pa.
Manufacturing Supervisor, Midvale Steel Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

GEORGE A. CUNNEY

1713 North Twentieth Street, Philadelphia, Pa.
Superintendent Northeast Boulevard for McNichol Paving and Construction Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

VERNON REA DUNLAP

5546 Broomall Avenue, Philadelphia, Pa.
Draftsman, Atlantic Refining Company.
Proposed by Charles B. Buerger, Fred C. Dunlap, and Lester M. Goldsmith.

HENRY F. GOLDSMITH

2308 North Broad Street, Philadelphia, Pa.
Julian S. Simsohn, Consulting Chemical Engineers.
Proposed by Lewis H. Kenney, W. M. Boehm, and Lester M. Goldsmith.

LOUIS LEROY HEPBURN

715 Vernon Road, Stenton, Mt. Airy, Philadelphia, Pa.
Foreman, Midvale Steel Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

JACOB RUSSELL HOXWORTH

Norristown, Pa.
With Alan Wood Iron and Steel Company.
Proposed by W. M. Boehm and Lewis H. Kenney.

COMMITTEE ON MEMBERSHIP

JAMES ANDREW JENSEN

3840 Lancaster Avenue, Philadelphia, Pa.
Engineer, Quaker City Iron Works.
Proposed by W. M. Boehm and Lewis H. Kenney.

ELLIS GEORGE JOSEPH

Y. M. C. A., Camden, N. J.
With New York Shipbuilding Corporation.
Proposed by Henry C. Adams, Jr., and S. H. Cornell.

THOMAS HUGHES LUDWICK

2321 North Cleveland Avenue, Philadelphia, Pa.
Asphalt Plant Foreman.
Proposed by W. M. Boehm and J. T. Schwartz.

EDWARD PAUL NOPPEL

2726 South Colorado Street, Philadelphia, Pa.
Electrical Inspector, Philadelphia Navy Yard.
Proposed by W. M. Boehm and Lewis H. Kenney.

SAMUEL ISAIAH SACKS

1755 North Thirty-first Street, Philadelphia, Pa.
Draftsman, Department of City Transit.
Proposed by Lawrence B. Manley and Stephen Harris.

MEYER HIRSCH SILVERMAN

1521 North Sixteenth Street, Philadelphia, Pa.
Substation Construction, Gibbs & Hill, Consulting Engineers,
P. R. R. Co.
Proposed by Lewis H. Kenney, W. M. Boehm, and Lester M. Goldsmith.

WILLIAM A. STEIGER

5543 Chester Avenue, Philadelphia, Pa.
Engineering Bureau of Steam Engineering, U. S. N.
Proposed by W. M. Boehm and Lewis H. Kenney.

HARRY RICHARD WEST

1631 Arch Street, Philadelphia, Pa.
Engineering Assistant, Bell Telephone Company.
Proposed by H. Mouradian, R. W. Welsh, and J. D. Ferry.

GEORGE BOLE HUTCHINSON

The Austin Company, Bulletin Building, Philadelphia, Pa.
Chief Clerk, Construction Department, The Austin Company.
Proposed by Harry W. Wardle and W. R. Rodgers, Jr.

POSITIONS OPEN

Draftsmen of general experience, men of integrity, reliability, and industry, with experience in general drafting, design, and layout work. Applicants state age, details of experience, salary expected, and references. Apply Engineers' Club, No. 177-A.

Wanted—Engineering draftsmen on automobile work. Apply Engineers' Club, No. 178-A.

Young engineering draftsmen, familiar with plant and equipment work, also building layouts. Apply Engineers' Club, No. 179-A.

Wanted: Several experienced locomotive elevation and detail draftsmen. Apply Engineers' Club, No. 180-A.

POSITIONS WANTED

Engineer desires position—sewerage or hydraulic engineering, or railroad construction. Apply Engineers' Club, No. 164.

Mechanical or civil engineering—designing or supervising construction. Apply Engineers' Club, No. 166.

Master mechanic desires position. Thoroughly familiar with large maintenance and construction work. Apply Engineers' Club, No. 167.

Engineer with knowledge of ornamental iron and boiler shop practice; sales and purchases, desires to connect with company in a position where he can gradually relieve owner of some of the burdens of management. Apply Engineers' Club, No. 170.

Safety engineer desires position. Good organizer and well up in safety work. Apply Engineers' Club, No. 173.

Electrical engineer, B.S. in E.E., 1911. Familiar with power-plant installations; heat treatment of steel, practical shop and laboratory experience. Familiar with the handling of men. Apply Engineers' Club, No. 174.

Consulting engineer desires position as master mechanic or works manager. Experienced in designing of mechanical and electrical equipment of buildings, specification writing, and supervising construction. Apply Engineers' Club, No. 175.

University graduate, Ph.D. Experienced in experimental and research work. Knowledge of optics, spectroscopy, and photometry. Experienced in testing tool steel, heat treatment, etc. Apply Engineers' Club, No. 177.

FOR SALE

Two first-class light mountain transits—one Young & Sons and one Heller & Brightly—\$135 each. Original price, \$235. Apply 2-B, Engineers' Club.

Proceedings of American Society of Civil Engineers for the last 22 years. Apply Engineers' Club, 1-B.

WANTED

Four 15-ton locomotive cranes equipped with grab bucket. Apply 4-C, Engineers' Club.

FOR RENT

Engineer absent from office most of the year wants to sub-rent one room or desk room of office suite in large office building—centrally located. Party can have use of the entire office for the period engineer is absent. Employs stenographer. A very attractive arrangement will be made with a responsible party. Apply Engineers' Club, No. 5-C.



JUNIOR SECTION

DR. WM. BOEHM, Chairman *Ex-Officio*

H. I. GOLDSTEIN, Chairman

A. B. BISHOP, Secretary



AMONG the advantages obtained from the recent Building Fund Campaign was the enterprising and lively spirit aroused among the Junior members. This happily coincided with plans made by the Junior Committee, which had arranged the May banquet. The Committee had retained its organization to be prepared for the fall campaign. The Junior ranks had been sadly depleted by members entering the Senior grade, and others, in one capacity or another, enlisting in the service of the country. It became necessary to make strong efforts to obtain new members. The Senior members recognized this fully, and assisted materially in many ways.

The Junior section team, which had taken such a conspicuous and active part in the Building Fund Campaign, having secured fifth standing among all the teams, elicited much favorable comment from the older members. With the other Section members this team was subsequently constituted into a committee of the whole, and invited all recent graduates of technical schools employed in and around Philadelphia to an informal meeting at the Clubhouse on October 9, 1917. This meeting was very successful, and many prospective Junior applicants were present and given every opportunity to become members. A short technical paper was read by Mr. Lewis H. Kenney, chairman of the Committee on Papers, and the president, Mr. J. A. Vogleson. Mr. C. W. Pike and Dr. W. M. Boehm also addressed the meeting. The advantages of the Club were brought to the attention of the eighty persons, members and non-members, present, and as a result thirty-five applications for Junior membership were received. It is confidently hoped to double the present increase of Junior members before the season is over.

Aside from the technical and business ends, which are all-important, the last, if not the least, reason for getting acquainted is the social feature. Some of these entertainments are now being planned. There will be an annual dinner at the January monthly meeting, also a ladies' night early in 1918, and as soon as the new addition to the dining-room is available.

At the last monthly meeting in November about fifty members and guests were present. The following papers were presented:

"Chemistry of Clays for Fire Brick and Fire Cements,"

By Leonard Zoole.

"Fire Brick and Cement in Oil Burning Boilers,"

By M. M. Kennedy.

Absent members really missed something, as the resulting discussion was decidedly interesting, entertaining, and instructive. For the December meeting only one paper, "The Measurement of the Flow of Liquids and Gases in Pipes," by Mr. L. M. Goldsmith, will be presented. The balance of the meeting will be devoted to a "Smoker." Members and their friends are cordially invited to attend.

The Publication Committee of the JOURNAL has reserved this page for reporting all the Junior activities. There are as yet no committee reports, but it is hoped all Junior members will scan this page to keep themselves posted and to read of matters of interest to Juniors.

It is incumbent upon us also to have this page for our friends and comrades in camp or in the trenches, as many members have recently been asked by them as to what is going on among the Juniors "at home."

The nucleus of a real and live Junior organization was formed by the appointment of an Executive Committee, which is as follows:

H. I. Goldstein, Chairman.

A. B. Bishop, Secretary.

W. Z. Kline, Chairman, Papers Committee.

L. M. Goldsmith, Chairman, Membership Committee.

A. de Macedo, Chairman, Meetings Committee.

A. P. Godsho, Public and Club Relations Committee.

W. W. Pickles, Chairman, Entertainment Committee.

The personnel of these several committees will be announced in a future issue of the JOURNAL.

COMMITTEE ON NATIONAL SERVICE

GUILLIAEM AERTSEN, CHAIRMAN

MEMBERS OF ENGINEERS' CLUB WHO HAVE BEEN CALLED INTO SERVICE IN THE ARMY OR NAVY OF THE UNITED STATES AS OF NOVEMBER 20, 1917

NAME	RANK	CORPS	LOCATION
ALDRICH, J. T.	1st Lieutenant	Ordnance Officers' Reserve Corps	Washington, D. C.
ALLEN, J. G.		Co. 12 Infantry, Reserve Officers' Training Camp	Fort Oglethorpe, Chattanooga, Tenn.
ANDERS, D. W.	Captain	Company D, 502nd Engineers	Overseas Service
ANDREWS, J. H. M.	Major	103rd Engineers	Camp Hancock, Augusta, Ga.
ASPLUNDTH, E. T.	Captain	103rd Engineers	Camp Hancock, Augusta, Ga.
ATTERBURY, W. W.	Brigadier-General	Director-General of Railways	France
BARKER, E. W., JR.		Truck 4-304 Ammunition Train	Camp Meade, Admiral, Md.
BATES, A. J.	Lieutenant	111th Infantry	Camp Hancock, Augusta, Ga.
BEAR, H. K.	Private	Co. "F," 315th Infantry	Camp Meade, Admiral, Md.
BELL, FRANK F.	1st Lieutenant	Signal Corps, Aviation Station	Gerstner Field, Lake Charles, Louisiana
BOOZ, H. C.	Major	In Charge of Construction of Railroads, Wharves, etc.	France
BORRESEN, W. Y.		315th Infantry	Camp Meade, Admiral, Md.
BOYD, F. F.	1st Lieutenant	U. S. Naval Reserve	U. S. S. "Jupiter"
BOYD, G.	1st Sergeant	Overseas Repair Section No. 1	Gas Defense Service, Medical Corps
BRADFORD, J. S.	Captain	103rd Engineers	Camp Hancock, Augusta, Ga.
BRANSOME, E. D.		Mass. Inst. Technology Aviation Camp	Boston, Mass.
BREAM, C. C.	Corporal	103rd Engineers	Camp Hancock, Augusta, Ga.
BREEN, J. W.	Captain	Engineer Officers' Reserve	
BROADHEAD, ALEX.		19th Reserve Engineers	American Expeditionary Forces, France
BRODERICK, D. F.	Major	Ordnance Officers' Reserve Corps	Rock Island Arsenal, Rockland, Ill.
BROWN, P. D.		Reserve Engineers	France
BROWN, R. V.	Lieutenant	Q. M. C., 304 Divisional Trains	Camp Meade, Admiral, Md.
BRYANT, C. M.		Naval Coast Defense	Philadelphia Navy Yard
BUTLER, E. N.	2nd Lieutenant	103rd Engineers	Camp Hancock, Augusta, Ga.
CACCAVAJO, JOS.	Captain	Engineers' Training Camp	Washington, D. C.
CARNEY, R. E.	{ Asst. Engr. U. } { S. N. (Retired) }	Pearl Harbor Naval Station	Hawaii
CHILDS, H. P.		7th Infantry, Reserve Officers' Training Camp	Ft. Myer, Va.
COLGAN, R. J.	Captain	American Expeditionary Forces	Care of Adjutant-Gen'l, Washington, D. C.
CRAMPTON, G. S.	Major	Director of Field Hospitals, 28th Div.	Camp Hancock, Augusta, Ga.
CUMINGS, C. A.	Captain	Quartermaster Officers' Reserve	Ft. Sam Houston, Texas
CUSTER, E. A.	Major	Ordnance Officers' Reserve Corps	Albemarle Bldg., New York
CUTLER, JAMES B.		Reserve Officers' Training Camp	Fort Oglethorpe, Chattanooga, Tenn.
DILL, C. M.		Company K, 319th Infantry	Camp Lee, Petersburg, Va.
DONNELLY, J. B.	1st Lieutenant	103rd Engineers	Camp Hancock, Augusta, Ga.
DOYLE, T. H.	2nd Lieutenant	Quartermaster Officers' Reserve	Camp Meade, Md.
DUNN, M. L.	Ensign	Reserve Officers' Quarters	U. S. Naval Academy, Annapolis, Md.
DYSON, C. W.	Captain	Bureau of Steam Engineering, U. S. N.	Washington, D. C.
ELCOCK, CHAS.	1st Lieutenant	103rd Engineers	Camp Hancock, Augusta, Ga.
FAUST, W. D.		1st Penna. Engineers	Camp Hancock, Augusta, Ga.
FULWEILER, J. E.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
GAILING, H. W., JR.	Private	Marine Corps (Aviation)	Philadelphia Navy Yard
GARDINER, F. M.	Lieutenant	U. S. Naval Reserve Corps	
GARFORTH, EZRA		Engineers' Training Camp	American University, Washington, D. C.
GAUM, CARL G.	1st Lieutenant	Engineers' Training Camp	Washington, D. C.
GAUTHIER, JORDAN	2nd Lieutenant	Engineers' Training Camp	American University, Washington, D. C.

ENGINEERS' CLUB OF PHILADELPHIA

GEST, J. B., 2ND	2nd Lieutenant	Engineer Officers' Reserve Corps	American University, Washington, D. C.
GETZ, RALPH F.		19th Reserve Engineers	American Expeditionary Forces, France
GILLAN, W. H., JR.	1st Lieutenant	Ordnance Officers' Reserve Corps	Washington, D. C.
GRACEY, A. L.	Private	Ordnance Officers' Reserve	Watervliet Arsenal
GRAVELL, W. H.		Engineers' Training Camp	American University, Washington, D. C.
GRIBBEL, W. G.	Captain	30th Engineers	Overseas Service
GRIFFIN, R. S.	Rear Admiral	Eng. in Chief, U. S. N. Bur. of Steam Engineering	Washington, D. C.
GWILLIAM, MARK R. M.	1st Lieutenant	21st U. S. Infantry	San Diego, California
HALL, W. A.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
HAMILTON, H. A.	1st Lieutenant	Engineer Officers' Reserve Corps	American University, Washington, D. C.
HARDING, R. L.		Engineers' Training Camp	American University, Washington, D. C.
HARROWER, R. A.		American Red Cross Ambulance Corps	France
HATHAWAY, H. K.	Captain	Ordnance Officers' Reserve Corps	Washington, D. C.
HAYDOCK, ROGER		Engineers' Training Camp	American University, Washington, D. C.
HENRY, J. C.		Headquarters Dep't 19th Reserve Engineers	American Expeditionary Forces, France
HETHERINGTON, S. C.	Lieutenant	315th Infantry	Camp Meade, Admiral, Md.
HICKEY, Y.		Co. 7, Reserve Officers' Training Camp	Fort Oglethorpe, Chattanooga, Tenn.
HOLLENBACK, E. E.	Major	109th Infantry	Camp Hancock, Augusta, Ga.
HOLLISTER, C. J.		Division Headquarters	Camp Hancock, Augusta, Ga.
HOUWEN, W. P.		Section Headquarters, United States Navy	Lewes, Delaware
HULME, NORMAN	Lieutenant	Co. 4, Engineer Officers' Training Camp	Fort Leavenworth, Kansas
JONES, JONATHAN	Captain	Engineer Officers' Reserve Corps	American University, Washington, D. C.
KENNEDY, J. H.		Aviation Section, Signal Corps	American Expeditionary Forces, France
KERN, F. X.		Engineers' Training Camp	American University, Washington, D. C.
KNEASS, E.	Ensign	U. S. Naval Academy	Annapolis, Md.
KNIGHT, C. C., JR.			Fort Oglethorpe, Ga.
KNOWLES, MORRIS		4th National Army Division Cantonment	Admiral, Md.
KRAUS, P. T.	Sergeant	{ Co. "D," First Telephone Battalion Signal Reserve Corps }	American Expeditionary Forces, France
LAWRENCE, G. E.	Lieutenant J. G.	Naval Coast Defense	Philadelphia Navy Yard
LAWSON, T. W.	1st Lieutenant	109th Infantry	Camp Hancock, Augusta, Ga.
LEA, E. S.	Major		
LEVIN, J.		2nd Officers' Training Camp	Fortress Monroe, Va.
LEWIS, J. C.		Engineer Officers' Reserve Corps	France
LUDWICK, W. H.		United States Coast Guard	Avon-by-the-Sea, New Jersey
MAGEE, J. W.	2nd Lieutenant	Engineers' Training Camp	American University, Washington, D. C.
MALTBY, F. B.	Major	Engineer Officers' Reserve Corps	Army Building, N. Y.
MCCLINTOCK, J. L.		U. S. Navy Radio Service	Parkway Bldg. <i>pro tem.</i>
MCCORD, J. B.	Captain	Ordnance Officers' Reserve	War Department, Washington, D. C.
MCCOY, J. F.		Aviation Section, Signal Corps	Princeton, N. J.
MCGARRIGLE, J. J.		2nd Officers' Training Camp	Fortress Monroe, Va.
McMILLAN, H. L.	Captain	Engineer Officers' Reserve Corps	American University, Washington, D. C.
MILLAR, E. A., JR.	1st Lieutenant	Ordnance Officers' Reserve	Camp Hancock, Augusta, Ga.
MOODY, WM. M.		Reserve Officers' Training Camp	Fort Oglethorpe, Chattanooga, Tenn.
MOON, T. E.	Private	Ordnance Department	Augusta Arsenal, Augusta, Ga.
MORAN, J. B.	1st Lieutenant	Ordnance Officers' Reserve Corps	Washington, D. C.
MYERS, W. T.	2nd Lieutenant	16th U. S. Cavalry	Mercedes, Texas
NEWLIN, E. M.	Captain	312 Machine Gun Battalion	Camp Meade, Admiral, Md.
NEWLIN, J. M.	Major	Engineer Officers' Reserve Corps	Amer. Embassy, London, care of Vice-Admiral Sims
NIXON-MILLER, M.	Captain	Company "B," 501st Engineers	Camp Merritt, N. J.
NOYES, S. H.	1st Lieutenant	1st Aero Squadron	Columbus, N. M.
OAKES, J. C.	Colonel	113th Engineers	Camp Shelby, Hattiesburg, Miss.
OTWELL, CURTIS W.	Colonel	104th Engineers	Camp McClellan, Anniston, Ala.
PERRY, EDWARD		Quartermaster Officers' Reserve	Camp Lee, Petersburg, Va.
PETERMAN, J. M.	Private		Camp Meade, Admiral, Md.
PFEFFER, H. W.	1st Lieutenant	Ordnance Officers' Reserve Corps	Bethlehem, Pa.
PRICHETT, F. B.		First Troop, Phila. City Cavalry	Camp Hancock, Augusta, Ga.
PUGH, M. R.	Major	21st Engineers	Camp Grant, Rockford, Illinois
RAWCLIFFE, J. F. B.	Sergt. Major	Battery 6, Field Artillery	Fort Oglethorpe, Chattanooga, Tenn.

COMMITTEE ON NATIONAL SERVICE

REED, R. W.	Private	19th Reserve Engineers	American Expeditionary Forces, France
REED, THOMAS	Captain	Ordnance Officers' Reserve Corps	Rock Island, Illinois
RENINGER, H. A.	{ Major & Adjutant, A.G. Dept. }	53rd Depot Brigade	Camp Hancock, Augusta, Ga.
RIDGE, R. S.	Sergeant	23rd Engineers	Camp Meade, Admiral, Md.
RIDGWAY, J. J.	1st Lieutenant	Co. F, 318th Infantry	Camp Lee, Petersburg, Va.
RITCHIE, J. M.	Captain	Quartermaster Officers' Reserve	Washington, D. C.
ROGERS, C. B.		Electrical Research Dept., Aviation Section, Signal Corps	Mineola, L. I.
ROOP, J. C.	Captain	17th Engineers	France
ROTH, F. E.	Private	316th Infantry	Camp Meade, Admiral, Md.
SANVILLE, L. F.	Private	108th Field Artillery, Penna. Troops	Camp Hancock, Augusta, Ga.
SCHMIDT, A. H.		Company "C," 315th Infantry	Camp Meade, Admiral, Md.
SCHWEGLER, O. F.		Reserve Officers' Training Camp	Fortress Monroe, Va.
SHUSTER, W. H., JR.	Lieutenant	314th Infantry	Camp Meade, Md.
SMITH, W. S.	Captain	Navy Department	Special Duty, Naval Consulting Board, Washington, D. C.
SPACKMAN, H. S.	Major	Engineer Officers' Reserve	Overseas Service
SPENCER, ALEX. G.		Royal Flying Corps	Toronto, Canada
SPILLAN, J. J. D.	Sergeant	Hq. 53, Brig. F. A.	Camp Hancock, Augusta, Ga.
TAWRESEY, J. G.	Naval Constructor	Navy Department	Construction Officer, Philadelphia Navy Yard
TAYLOR, H.	1st Lieutenant	304th Regiment Engineers	Camp Meade, Admiral, Md.
THACHER, C. F., JR.	1st Lieutenant	Engineer Officers' Training Camp	Belvoir, Va.
THACHER, C. H.	2nd Lieutenant	Engineer Officers' Training Camp	Belvoir, Va.
THOMAS, R. S.	Captain	Engineer Depot	Eagle Pass, Texas
THOMSON, H. A.		Quartermaster Officers' Reserve	Camp Hancock, Augusta, Ga.
TILLSON, P. E.	Lieutenant	Naval Coast Defense	Philadelphia Navy Yard
VAUGHAN, D. L.		Officers' Reserve Corps	
WARFEL, A. C.	2nd Lieutenant	35th Regiment Engineers	Camp Grant, Rockford, Ill.
WARFEL, J. P.	Senior Lieutement	U. S. Naval Reserve Force	Philadelphia Navy Yard
WATSON, G. L.	Captain	Engineer Officers' Reserve Corps	
WHITE, W. M.	1st Lieutenant	103rd Engineers	Camp Hancock, Augusta, Ga.
WILD, H. J.	Captain	Engineer Officers' Reserve Corps	War Department, Washington, D. C.
WOERWAG, C. A.	1st Lieutenant	Ordnance Officers' Reserve Corps	
WORK, LEONARD	1st Lieutenant	Signal Corps Aviation Section	Overseas Service
WORRELL, H. S.	Lieutenant	C. A. C. School D	Fort Monroe, Va.
WORTH, J. G.	Captain	Quartermaster Officers' Reserve	Camp Wheeler, Macon, Ga.
ZINN, GEORGE A.	Colonel	District Engineers' Office, Custom House	Portland, Oregon

REQUEST FOR INFORMATION

THE COMMITTEE REQUESTS THAT THE MEMBERS OF THE CLUB INFORM THE COMMITTEE OF THEIR ADMISSION TO THE MILITARY OR NAVAL SERVICE.

THE COMMITTEE WOULD ALSO BE PLEASED TO RECEIVE SUGGESTIONS FROM MEMBERS WHO HAVE ENTERED THE SERVICE . PLEASE ADDRESS COMMUNICATIONS TO THE COMMITTEE ON NATIONAL SERVICE.



ILLUMINATING ENGINEERING SOCIETY PHILADELPHIA SECTION

WALTON FORSTALL, Chairman

UNIT RASIN, Secretary, 1411 Widener Bldg.



THE monthly meeting of the Society, preceded by the usual dinner, was held on October 19. Anyone is welcome to join the others at dinner on meeting night, by notifying the Chairman of the Dinner Committee or the Club office.

The first part of the meeting considered and discussed the exhibition, which consisted of a number of semi-indirect lighting fixtures. For some years these exhibitions have been a feature of the meetings whenever possible, and the objects shown have been selected, where possible, with reference to the subject of the meeting.

The paper on the "Economics and the Operation of Large Lighting Installations," written by Clarence L. Law and James E. Buckley, of New York, was read by Mr. G. B. Regar, of the local section. The paper dealt with methods used by the Bureau of Illumination of the New York Edison Company in making investigations and recommendations on existing installations to reduce the cost of lighting. The installations, installed some years ago, previous to present knowledge of lighting and lighting conditions, require the most changes. The classes of installations, particularly investigated, were office and loft buildings, halls, and clubs having their own buildings. In order to show the importance of the lighting load as compared with the total consumption of a building the following table is quoted from the paper:

	Including electric elevators (per cent. consumption)	Excluding electric elevators (per cent. consumption)
Loft building	43	98
Office building	59	90
Hotel building	47	90
Club building		82
Department store building ..	75	79

The general method of investigation consists in making a detailed survey of the building, including the number and size of lamps and the style and location of fixtures. The wiring also is traced out, so that the general system and control of the various fixtures and lamps is known. When necessary, meters are installed to measure the current consumption, and temporary lamps are installed for experimental purposes. From the results thus obtained the final recommendations are made.

When making these investigations, it is frequently necessary to cover the entire 24 hours, as in many cases considerable lighting is used at night for cleaning and other purposes. In one case investigated, the consumption for lighting, between the hours of 6 P.M. and 8 A.M., was 29 per cent of the consumption for the total 24 hours.

It was also found that in many installations, particularly where the fixtures permitted the accumulation of dust, the intensity of the illumination from this cause was reduced from 20 per cent to 40 per cent. It was further found, however, that when such condition was brought to the attention of those in charge the same fault did not occur to the same extent a second time.

The complete paper, with the discussion thereon, will be printed in the *Transactions of the Society*.

The January JOURNAL will contain the paper, "Historical Lighting of Independence Square," presented by Mr. E. F. Kingsbury, at the meeting on November 16.



SOCIETY OF AUTOMOTIVE ENGINEERS PENNSYLVANIA SECTION

JOHN W. WATSON, Chairman

A. K. BRUMBAUGH, Secretary, Autocar Co., Ardmore, Pa.



THE second meeting of the season was held at the Engineers' Club, Thursday evening, November 22, the subject being "Size, Inflation Pressure, and Construction of Tires as Affecting Easy Riding." The discussion was opened with a paper by J. E. Hale, experimental engineer of the Goodyear Tire and Rubber Company, Akron, Ohio.

A lengthy discussion was entered into by several tire manufacturers, much enlightenment being thrown on the disputed points regarding the design, manufacture, and use of pneumatic tires.

Mr. Hale's paper will be published in the January issue of the JOURNAL.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS .:. PHILADELPHIA SECTION

NATHAN HAYWARD, Chairman

H. MOURADIAN, Secretary, 1631 Arch Street

AT the November meeting Mr. William F. Johnson presented a paper descriptive of the regular routine tests made by the Philadelphia Electric Company to maintain its indicating, recording, and integrating meters with standard accuracy. He showed by lantern slides the equipment required in the primary, secondary, and working standards to carry on the checking, calibration, and adjustment of the service meters. It was pointed out that, during the last ten years, the standard to which the accuracy of meters, both service and switchboard, is maintained, had undergone a very striking improvement and that now all service meters are adjusted to within 2 per cent. accuracy above or below reading. A description was given of the specially arranged switchboards and calibration benches, showing the facilities provided for rapid and accurate work.

In the discussion, Dr. Carl Hering pointed to the consumer's position in the case of electric meters as contrasted with his position in the case of other meters, particularly in the early days of gas usage. He said there is no commodity that lends itself to more accurate metering than does electricity. Mr. Liversidge said that the number of meters found inaccurate after tests, due to complaints from consumers, was very small indeed. Practically all complaints on excess charges were found to follow actual extra consumption of power on the part of the consumer.

Mr. H. C. Blackwell, of G. M. Guest Company, New York, will read the major paper at the regular meeting to be held in the auditorium of the Engineers' Club, December 12, at 8 P.M. Preceding the meeting

there will be the usual informal dinner in the Club dining-room.

The subject of the paper will be "Electricity and Conduit Construction," and will be a descriptive lecture on conduit construction from the construction standpoint. Conduit *versus* overhead construction types of systems, manufacture of materials and illustration of their use, manholes, cable work, splices, etc., will be presented for discussion. There will be illustrations of ornamental street lighting, and the peculiarities of railway work will be shown.

There will be motion pictures of:

1. Methods used in United States. Modern ways of rock excavation, pulling and splicing cables.
2. Progressive methods in Canada. Showing the lines from the Shawinigan Power Plant to Montreal.
3. English methods, as exemplified by views around London.
4. Construction work in progress at military encampments.

Preceding Mr. Blackwell's paper, Mr. W. L. Robertson will present a short paper on the subject of "Annual Load Relief Map, Peak Load and Load Factor Analysis."

Mr. Robertson has prepared a set of curves showing the load for the Philadelphia Electric Company by days for each hour of the day. By combining these he has secured a surface or relief map of the year's load. The paper will discuss the various factors involved in the curves and the analysis of the load "surface" and its relation to peaks.

SPECIAL NOTICE.

ORDNANCE OFFICERS' RESERVE CORPS

General information for applicants desiring appointment in the Ordnance Officers' Reserve Corps was published in the July issue of the PROCEEDINGS, page 320.

There are yet a few vacancies for engineers for special duty. It is therefore suggested that any of the members of the Club interested in this branch of the service file applications in order that the Department may have information available, and can make appointments when the qualifications and experience of the applicant meet the requirements of the service.

PHILADELPHIA LOCAL SECTION No. 7 OF

M. W. RUDDEROW, Acting President



SAFETY COUNCIL NATIONAL SAFETY COUNCIL

J. P. MUDD, Secretary-Treasurer,
The Midvale Steel Co., P. O. Box 1322

IT is with a great deal of pleasure the Executive Committee announces to the members the affiliation of the Council with the Engineers' Club of Philadelphia.

It should be emphasized at the outset that the Council in this affiliation in no way loses its identity. Its name, its constitution, its offices, its ideals and workings remain the same. Its activities, we hope, will be broader and of more influence than ever before.

The Engineers' Club auditorium seats about 200. It will be enlarged and renovated, and in its larger size will accommodate about 400 persons. Regular monthly meetings will be held in the auditorium from now on. A full schedule of subjects, speakers, etc., will appear in a later issue.

The house at 1317 Spruce Street will be our permanent headquarters. A very excellent library with most of the technical publications is at the service of members.

The auditorium is ventilated by a forced-draft system, and its equipment includes the most modern type of stereopticon and moving-picture machine.

On meeting days Philadelphia Safety Council members

are allowed all the privileges of regular club members. Downtown members of the affiliated societies frequently dine at the Club prior to meetings. The service is good and at reasonable cost.

Meetings notices are sent out by the Club free of cost.

Other associations affiliated with the Club are branches of national associations, and the Local Safety Council will be the gainer by association with the various units. Joint meetings are frequently held and the Council will no doubt also participate.

Every member will hereafter regularly receive this JOURNAL. Look in each issue for the P. S. C. page.

Please bear in mind that there will be no increase in dues of the local Council on account of the added advantages which we are to enjoy.

It might be added that there never was a time in the history of the country when it was more vital to produce goods in factories and to conserve life and limb and health than the present, because in promoting safety we promote the happiness that goes with added production and full working time.



AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS EASTERN PENNSYLVANIA CHAPTER

GEORGE W. BARR, President

GEORGE BOON, Secretary



A REGULAR monthly meeting was held Thursday evening, October 8, with President Barr in the chair. After hearing the reports of the Secretary and all standing committees, President Barr introduced Dr. Milton W. Franklin, Consulting Engineer, who addressed the meeting on the subject, "Shop Organization and Business Efficiency."

Doctor Franklin, in his remarks, claimed that while "team work" and "coöperation" were necessary, the "human element" was the chief consideration for lasting efficiencies; and cited the German methods of application during and since the Franco-Prussian War,

proving that when the "human element" was neglected, the results were disastrous.

The Committee on Meetings requests that members send to the Secretary in writing the subjects they wish presented at meetings for discussion.

The next regular meeting will be held Thursday evening, December 13, at 8 o'clock; the subject for discussion will be "Modern Heating and Ventilating Appliances for School Buildings."

The paper entitled "General Utilization of Pulverized Coal," read by H. R. Collins at a recent meeting, will be found on page 556.



TECHNOLOGY CLUB OF PHILADELPHIA



H. A. TERRELL, President.

N. A. WHITE, Secretary, Wenonah, N. J.

December Meeting.

The next meeting of the Technology Club will be held on Wednesday evening, December 5, 1917. There will be an informal dinner at the Club at 6.30 P.M. and meeting at 8.15 P.M. Dr. Hollis Godfrey, '98, president of Drexel Institute and president of Technology Clubs Associated, will speak on the year's work of the Advisory Commission of the Council of National Defense, of which he is a member. It is expected that T. Coleman duPont, '84, will also be present at this meeting and will address the Club.

Members of the Engineers' Club and Affiliated Societies are invited to the meeting.

Technology War Activities.

The important part which engineering plays in modern war is reflected in the varied activities of the technical schools and colleges of the country. The following list of war activities of the Massachusetts Institute of Technology is of interest in this connection:

1. Under arrangement with the Secretary of War, the Institute is maintaining a School of Military Aeronautics attended constantly by three hundred students sent by the War Department, forty arriving each week for a course of eight weeks.

2. Under arrangement with the Secretary of the Navy, it is maintaining a School of Aeronautics attended constantly by three hundred students, sixty men being sent by the Navy Department each fortnight for a term of ten weeks.

3. Under arrangement with the Secretary of the Navy, it is also maintaining a school for Naval Inspectors of Material and Construction of Motors and Aeroplanes.

4. Under direction of the Secretary of the Navy, it has maintained a Naval Reserve School, leading to an Ensign's commission in the Naval Reserve, the course being four months. This course, which had an attendance of sixty, has recently been transferred to Harvard University, owing to the increasing demands of the above schools on the available space.

5. By arrangement with the United States Shipping Board, it is maintaining a School of Instruction for Navigating Officers in the merchant marine, having a constant attendance of forty men sent by representatives of the Government. This school is under the general direction of Dean Burton, of the Institute, he having also, on behalf of the Government, general supervision over thirty similar schools located on the Atlantic, Pacific and Gulf coasts.

6. By an arrangement with the United States Shipping Board, it is maintaining a School for Engineers in the merchant marine, having an attendance of sixty, under the supervision of Professor Miller, head of the Department of Mechanical Engineering, who has general oversight of the seven similar schools in other places.

7. At the beginning of the war, it maintained, under

the direction of Professor Peabody, a ten weeks' course in Naval Architecture open particularly to those who had completed their work in other engineering courses. From this school there have been forty-five graduates, every one of whom is in the service of the Bureau of Construction and Repairs. A repetition of this course has been arranged for the coming term.

8. At the beginning of this academic year, the War Department established Reserve Officers Training Corps for technical branches of the army. At present these are open to students of the first and second years only. In addition to the regular work of certain engineering courses, students joining these corps take prescribed military work. Students in these corps and in the Volunteer Advance Battalion of the upper two years appear in service uniform at all exercises of the Institute.

9. During the summer it maintained, thru the generosity of Mrs. Edward Cunningham, a military camp at East Machias, in which ninety sophomores were given special training in work of the military engineer.

10. During the summer it maintained special courses permitting two hundred members of the Junior class to anticipate a large amount of next winter's work, in order that they might either be graduated at an earlier date or have more time for military work. The academic work took place in the forenoon, the afternoon being devoted to drilling and to military instruction.

11. The regular camp for Civil Engineers, with military work added, was maintained during the summer.

12. The Walker Memorial has been appropriately dedicated by being put into use as a dormitory and general messroom for the men in the War Schools. Thruout the summer they were lodged and fed by the Institute in the main buildings.

This service by the Institute has involved not only

(Continued on Page 598)



WORCESTER TECH CLUB

GEORGE A. DENNY, Chairman

ROBERT M. BARR, Secretary, Land Title Building



Meeting January 3, 1918, at the Club House.

Mr. Alfred D. Flinn, Deputy Chief Engineer, Board of Water Supply, New York City, will present an illustrated address on "**New York Catskill Mountain Water Supply.**"

The members of the Engineers' Club are cordially invited to attend this meeting.

THE Worcester Tech Club met for the first of the winter meetings on Thursday, November 1, at the Engineers' Club, for the purpose of discussing plans for the year and approving the schedule of monthly talks arranged by the Executive Committee.

The schedule has been definitely prepared for all but the two spring meetings, and is as follows:

December 6.—Ambrose G. Warren, E.E., General Superintendent of J. W. Paxson Company. Subject, "Modern Foundry Machinery." Illustrated with lantern slides.

February 7.—Arthur H. Allen, M.E., Manager,

Triumph Electric Company. Subject, "Compression Rheostats." Illustrated with lantern slides.

March 7.—Annual Dinner. President Ira N. Hollis to be invited.

The April and May subjects will be announced later.

Members are asked to remember the first Thursday of each month as a Tech evening and make it a point to attend. Also bring any Tech men, enrolled or not; the latter can join at once.

Remember the dinner at 6.30 P.M., preceding the Regular Meeting.

TECHNOLOGY CLUB OF PHILADELPHIA

(Continued from Page 597)

a considerable outlay of money, but also ceaseless industry and marked self-sacrifice on the part of the faculty, administrative officers, and instructors. Many of these men, moreover, as well as members of the Corporation, are giving a great part of their time to special work for the Government in matters of research, organization, and professional advice.

In addition to this notable work of the Institute itself, the Massachusetts Institute of Technology Alumni, as individuals, and thru organizations, are giving varied and important assistance to the Government. They are to be found in every branch of the Federal and State service, as well as in such organizations as the Red Cross, both in this country and abroad. The Alumni Association, in coöperation with the Technology Clubs Associated, has undertaken, among others, the following activities:

1. Thru a special Committee on the Mobilization of Technology's Resources, it took a special census of the alumni, thereby establishing a personnel list which has been of high value in furnishing men greatly needed by the Government. This work is still going forward both directly and in conjunction with the United States Public Reserve, the Engineering Societies, and other agencies.

2. Thru the Technology Clubs Associated there was early established at Washington an office (908 Union Trust Building) for giving information to Alumni concerning matters connected with the war emergency, and for bringing the various Government departments and Technology men together. The work of the Mobilization Committee and of the Technology

Clubs Associated has been united in the existing Massachusetts Institute of Technology Committee for National Service.

3. Early in June, Van Rensselaer Lansingh, '98, was sent by the Alumni to Paris to open there headquarters for Technology men. He proved to be the pioneer in establishing the Paris activities of the American University Union, an organization of the leading colleges and universities to look after the interests of their alumni in service on foreign soil, and to maintain for them a clubhouse, or clubhouses, abroad. Lansingh is now the business manager of the American University Union, and a second representative of Technology is soon to go over.

4. It has coöperated with the undergraduates in a reorganization of *The Tech*, under which that paper has become, for the period of the war, the organ of the Alumni as well as of the student body.

5. It has sent Professor Pearson, of the faculty, on a tour to many of the Technology Clubs to acquaint them with what the Institute has done and is purposing to do. This plan of sending men to cities where there are numbers of Technology Alumni will be carried forward on a more extensive scale.

6. It is securing as complete data as possible concerning Massachusetts Institute of Technology men and women engaged in all forms of war service.

7. It has enlisted the coöperation of a body of women interested in the Institute who, under the chairmanship of Mrs. Edward Cunningham, have established the Massachusetts Institute of Technology War Service Auxiliary.

THE RELATION OF THE BANKER TO INDUSTRIAL CHEMISTRY

(Continued from Page 564)

The pace which he must observe is being set for him without any particular reference to his inclinations or to the habits he may have formed. The developments of modern business demand certain classes of banking service, and also demand that in providing this service the bank should perform up to a certain standard of excellence.

Naturally a discussion at the present time upon two such nationally important subjects as chemistry and banking, particularly in relation to business, would include consideration of the greatest business enterprise in which this or any other nation ever has taken part—the war. The theory that the true relation between chemistry and banking is found in business finds considerable justification even in conditions existing before the war. When viewed in the light of the wonderful new things the war has brought into the world, the conclusion becomes irresistible. The indifference with which in former years private interest viewed national problems and difficulties finds but slight resemblance to the magnificent response which everywhere has been made to the nation's call. So,

while considering the business relationship between chemistry and banking, we should concede sufficiently the advantages which will result to both from a proper getting together, but we must not lose sight of the fact that the big thing in this relationship will be the national interest. For us there are just two worth-while things in the world to-day—one, to win the war; the other, to protect American interests afterward. Naturally, winning the war comes first, but preparations to that end should be definitely based upon the understanding that wars are to be won principally that nations may live in greater peace and security and prosperity afterward.

We must realize that the friendships and alliances of war need not control the international relations of the future. We must not forget that the ancient struggle for commercial mastery of the world is based upon conditions which will exist until the end of time, and that this struggle will be taken up again upon the day when peace is declared, not less strenuously than before, and in it we must be prepared to protect our own interests in peace no less seriously than we now protect them in war.

THE UTILIZATION OF NITRE CAKE

(Continued from Page 568)

carbonate and decomposing the soaps (sodium resins) formed in the digestion of the wood with the caustic liquors. Mr. Morrison claims that a very objectionable frothing, which ordinarily takes place in the evaporator, is thus prevented, or at least reduced to an extent where it does not give appreciable trouble.

Mr. Morrison's claims are briefly:

1. The utilization of a lower-priced material nitre cake for a higher-priced material salt cake.
2. A more thoro reduction of the sodium sulphate in the smelters as a result of the intimate mixture of black liquor and sulphate solution which will take in their evaporation together.
3. The utilization of the carbon dioxide generated in his procedure for the prevention of frothing in the vacuum evaporator.

Nitre cake is also used in the paper industry to replace sulphate of alumina. The present scarcity of sulphate of alumina has induced the paper makers to look for substitute ingredients. As such, bisulphate of sodium, which has often been proposed—and but recently by Dr. Klemm in *Wochenblatt für Papierfabrikation*—turned out best because of its easy adaptability. It can be bought in sufficient quantities at a reasonable price. As a solid body it can be easily worked and readily dissolves in cold water.

For important chemical reasons it would not be advisable to substitute the entire amount of sulphate of alumina until now used for gluing purposes by bisulphate.

It will be well to retain 50 to 60 per cent. of the amount of salt of alumina thus far used and substitute the balance of 50 to 40 per cent. by bisulphate.

As 1 kilogram of bisulphate is almost equal to $2\frac{1}{2}$ kilograms of sulphate of alumina in regard to its chemical action, only 20 per cent. of bisulphate is required to substitute the remaining 50 per cent. of sulphate of alumina.

The question now arises as to how the gluing of the material in the Holländer by the joint adaption of bisulphate should be done. For an extended operation the following method has turned out well:

In the first place, the usual amount of milk of lime is admitted to the pulp, then, after complete mixing, the half or 60 per cent. of the usual amount of sulphate of alumina is admixed and, 15 minutes later, bisulphate is added in a cold solution of 20 to 25 grams per litre.

The pulp water turns blue litmus paper to red if the described proportion of quantities is kept up.

The paper attains a solid and safe gluing. Coloring, even in delicate shades for high-grade papers, whiteness, touch, and hardness, is not influenced by the combination of sulphate of alumina with bisulphate of sodium if purified salt is used.

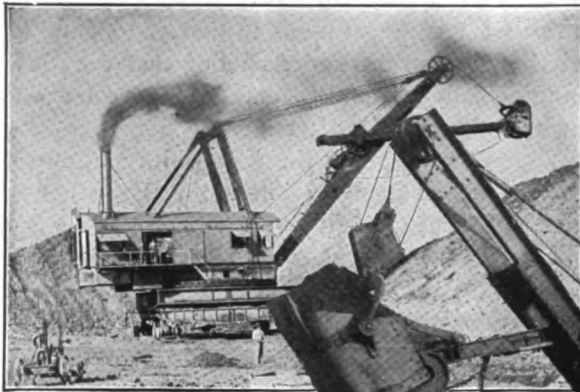
Most of the processes in which nitre cake is actually used have now been enumerated. There are hundreds of others in the experimental stage, and it can be said that in a short time there will be no necessity for any manufacturers to throw away nitre cake.

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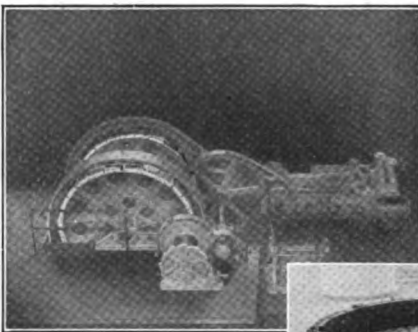
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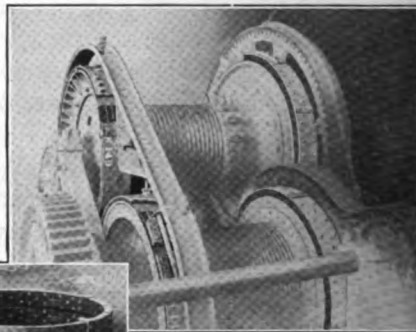
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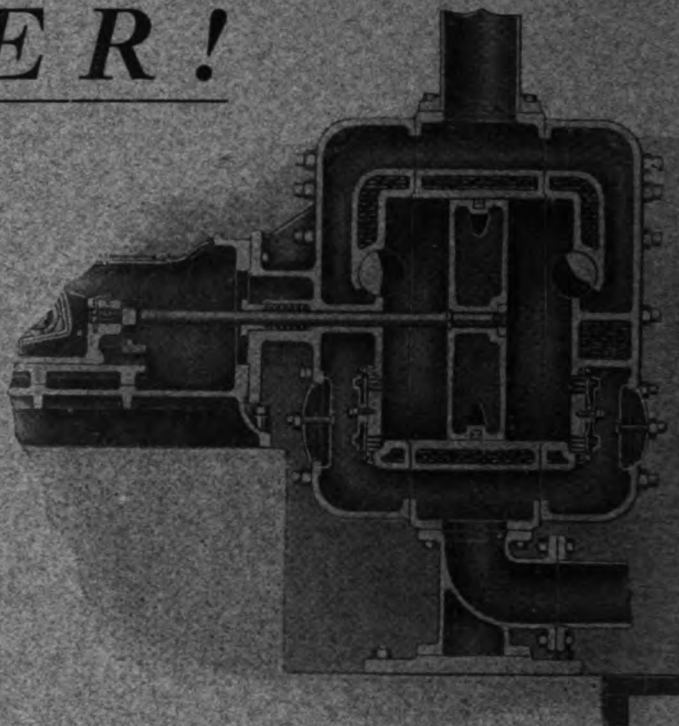
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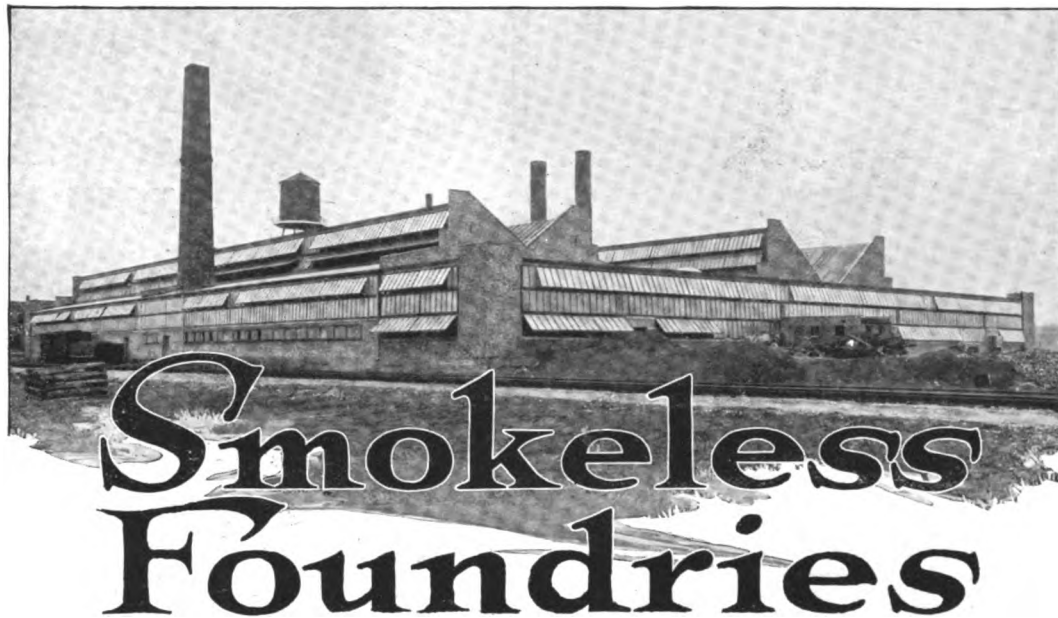
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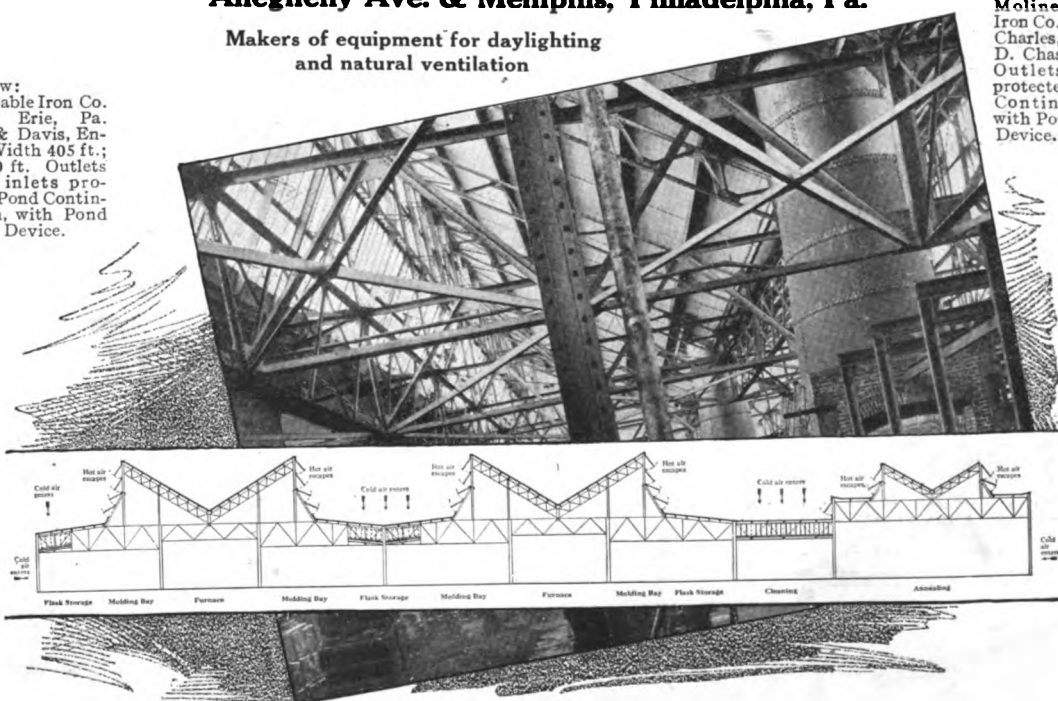
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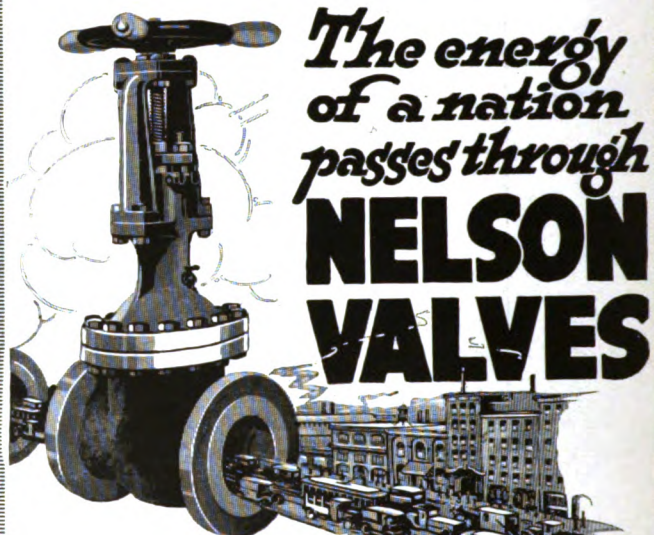
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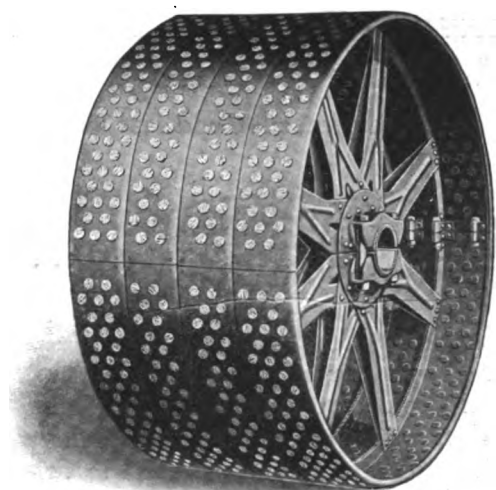
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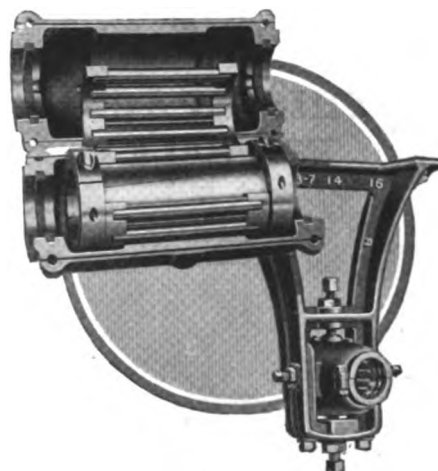
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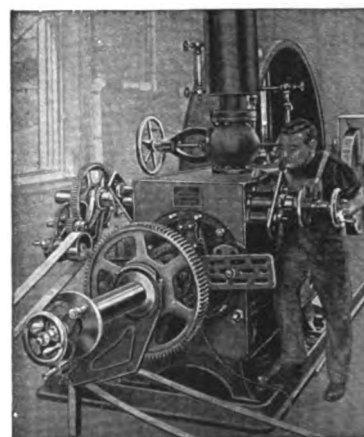
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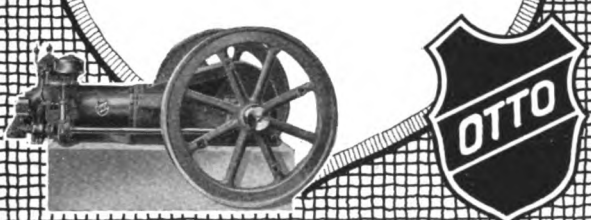
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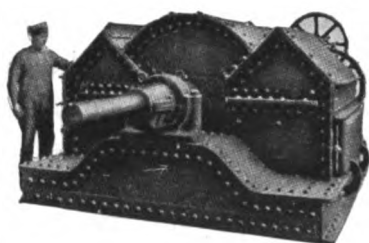
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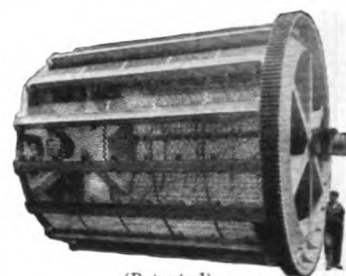
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INDEX TO ADVERTISERS

Name	Page
Albright & Mebus	viii
Alan Wood Iron and Steel Co.	
Allison, Walter A.	viii
American Pulley Co.	iv
Atlantic Refining Company, The	vii
Autocar Company	Inside back cover
Baldwin Locomotive Works, The	x
Ballinger & Perrot	viii
Berryman Co., Robert J.	viii
Bonine, Charles E.	viii
Braemer Air Conditioning Corporation	viii
Chance & Co., H. M.	viii
Chestnut Street Engraving Co., Inc., The	x
Colby & Christie	viii
Crew Levick Co.	
Day & Zimmermann, Inc.	viii
De Frain Sand Company, The	ix
Directory of Professional Cards	viii
Du Pont Fabrikoid Co.	v
Dyer, W. E. S.	viii
Elcock, John J.	
Gatchel & Manning	ix
Hammond & Co., R. R.	viii
Harrisons, Inc.	
Jackson, Wm. Steell	viii
Jellett Co., Stewart A.	viii
Ketzer Machinery Company	viii
Keystone Lubricating Company	Inside front cover
Link-Belt Company	Outside back cover
Lippincott Company, J. B.	552, xi
Lupton's Sons Company, David	ii
Mormann, Geo.	viii
Nelson Valve Company	iii
Newhall, George M.	viii
Otto Engine Manufacturing Co.	vi
Parker, E. H.	viii
Pennsylvania Crusher Co.	vii
Professional Directory	viii
Rooksby & Co., E. J.	v
Royersford Foundry and Machine Company	iv
Sauer & Company, Andrew J.	viii
Scofield Engineering Company	viii
Shannon & Co., J. J.	vi
Shoemaker, Benj. H.	vii
Smith, Edwin F.	
Thermoid Rubber Co.	i
Third National Bank	vi
Trautwine, J. C., 3d	viii
Vulcanite Portland Cement Co.	
Warren-Knight Co.	vi
Weber, F. & Co.	viii
Whitaker, Norman T.	viii
Wood, Albert C.	viii
Yarnall-Waring Company	iii

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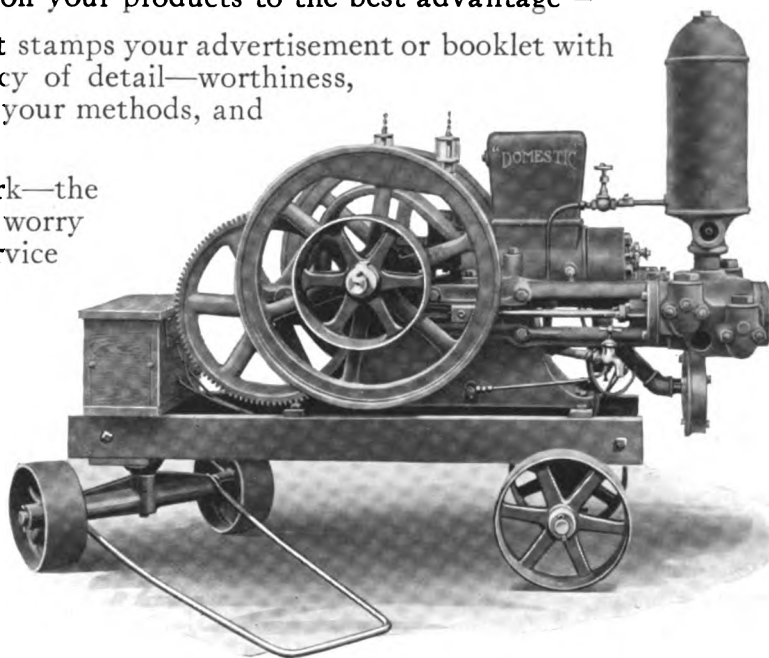
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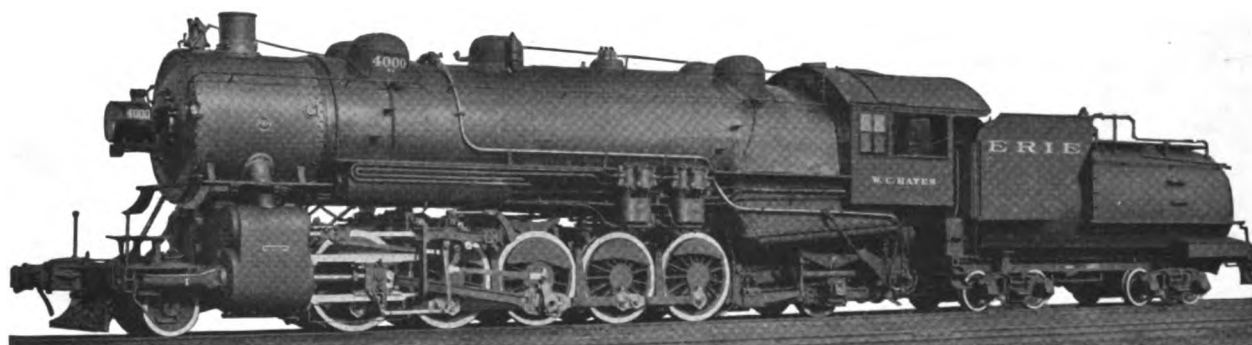


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PHILADELPHIA AND LONDON
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INDEX TO VOLUME XXXIV

Abstract of Minutes of the Board of Directors.....	61-69-116-162-204-261-307-434-487-519
Abstract of Minutes of the Club.....	61-69-116-161-204-258-310-487-519-585
Address of the President, Emmett B. Carter, The Engineers' Club of Today and Tomorrow	274
Address of the Retiring President of Illuminating Engineering Society, William J. Serrill.....	527
Addresses presented at Fortieth Anniversary of Engineers' Club of Philadelphia.....	234
Allen, J. G. Efficiency Work as Applied to Clerical Forces.....	574
Amendments to Rules and Regulations of the Bureau of Health of the City of Philadelphia.....	234
Arthur, Walter. Initiation of Explosions.....	135
As We Pause by the Wayside. By S. M. Swaab.....	120
Asphalt Industry, The. By James L. Rake.....	11
Automotive of War, The. By Joseph A. Steinmetz.....	190
Average Results of Tests of Portland Cement made during 1916.....	196
Balderston, Lloyd. Leather—Treatment and Manufacture.....	287
Baldwin, George P. Commercial Field for the Engineer, The.....	147
Bassett, Edward M. Zoning System, The.....	173
Binz, G. A., and D. Robert Yarnall. Recent Development in V-Notch Weir Measurement.....	314
Bliss, George S. Weather Business, The.....	267
Building and Equipment Fund Campaign, The.....	426
Caccavajo, J. Welfare Work.....	121
Carter, Emmett B. Address of the President, The Engineers' Club of Today and Tomorrow.....	274
Central Offices and Some Types of Switchboards, by J. H. Mahan.....	27
Chemical Research in Philadelphia, by Edgar Fahs Smith.....	129
Cheyney, George S. In Memoriam.....	486
Code of Lighting, Factories, Mills and Other Work Places.....	364
Commercial Field for the Engineer, The. By George P. Baldwin.....	147
Crawford, Andrew Wright. Zoning System, The.....	173
Datesman, George E. Zoning System, The.....	173
Department of Wharves, Docks and Ferries of the City of Philadelphia, The.....	73
Design, Construction and Equipment of a Modern Military Aeroplane. By J. C. Hunsaker.....	195
Discussion of the Fundamental Principle of Water-Works Valuation, A, By J. W. Ledoux.....	441
Early Chemical Manufacturing in Philadelphia. By Samuel P. Sadtler.....	411
Economics of Power Plants. By Francis R. Weller.....	81
Editorials:	
Amendments to the Club's By-Laws.....	3
Company "B," Pennsylvania Engineers.....	67
Junior Section, The.....	379
Making of Engineering Reports, The.....	481
New Clubhouse, The.....	113
Position of the Chemist, The.....	425
Technical and Higher Education.....	212
Zoning or Districting of Cities, The.....	159
Educational. By J. W. Ledoux.....	212
Efficiency Work as Applied to Clerical Forces. By J. G. Allen.....	574
Electric Code—Adopted by the Industrial Board, Pennsylvania Department of Labor and Industry.....	450
Engineering and Construction Features of Cantonments. By Major Richard C. Marshall, Jr.....	553
Ferguson, Homer L. War's Effect on Merchant Shipbuilding, The.....	499
Ford, George B. Zoning System, The.....	173
General Utilization of Pulverized Coal. By H. G. Barnhurst.....	556
Godsho, A. P. "Present Worth—Telephone Engineering Methods".....	23
Gracey, A. L. The Traffic Department—Telephone Engineering.....	25
Haldeman, B. A. Ninth National Conference on City Planning, Kansas City, Missouri.....	321
Hering, Carl. Much-Abused Term "Mass" in Engineering Calculations, The.....	571
Holland, J. P., Jr. Inception and Development of the Submarine Boat, The.....	279
Hollister, C. J. Oral Engineering at the Front.....	18
Hunsaker, J. C. Design, Construction and Equipment of a Modern Military Aeroplane.....	195
Inception and Development of the Submarine Boat, The. By John P. Holland, Jr.....	279
Indirect Lighting System. By G. Harry Swanfeld.....	97
Industrial Research and Its Relation to University and Governmental Research. By C. E. Skinner.....	546
Industrial Research and the Colleges. By A. E. Kennelly.....	549
Influence of the War on Submarine Policy, The. By Marley F. Hay.....	576
Initiation of Explosions. By Walter Arthur.....	135
Iyenaga, Toyokichi. Japan and America in the World War.....	351
Jackson, John Price. Pennsylvania Electric Code, The.....	449
Japan and America in the World War. By Dr. Toyokichi Iyenaga.....	351
Kennelly, A. E. Industrial Research and the Colleges.....	549
Kline, Wilmer Z. Philadelphia Bridges—Past, Present and Future.....	354

Layout of Machine Tools for a Large Light Manufacturing Plant. By David J. Matlack.....	362
Leather—Treatment and Manufacture. By Lloyd Balderston.....	287
Ledoux, J. W. Educational.....	212
Ledoux, J. W. Discussion of the Fundamental Principle of Water-Works Valuation, A.....	441
Lehman, Ambrose Edwin. In Memoriam.....	273
McCrudden, J. F. Two Conventions.....	567
Mahan, J. H. Central Offices and Some Types of Switchboards.....	29
Marshall, Richard C., Jr., Major. Engineering and Construction Features of Cantonments.....	553
Matlack, David J. Layout of Machine Tools for a Large Light Manufacturing Plant.....	362
Members of Engineers' Club who have been called into service in the Army or Navy of the United States, as of December 20, 1917	591
Military Aeronautics. By Major William Mitchell.....	324
Much-Abused Term "Mass" in Engineering Calculations. By Carl Hering.....	571
Ninth National Conference on City Planning, Kansas City, Missouri. By B. A. Haldeman.....	321
Notes on the Electric Storage Battery. By Edward Wanton Smith.....	395
Obituary Notices: George S. Cheyney.....	486
Ambrose Edwin Lehman.....	273
Otto C. Wolf.....	78
O'Reilly, G. A. Relation of the Banker to Industrial Chemistry, The.....	562
Oral Engineering at the Front. By Clark J. Hollister.....	18
Pennsylvania Electric Code, The. By John Price Jackson.....	449
Philadelphia Bridges—Past, Present and Future. By Wilmer Z. Kline.....	354
Position of the Engineer in the Community and His Relations to the Contractor, The. By S. M. Swaab.....	415
Problems in Ignition Development. By H. E. Rice.....	331
Progress Notes: Incandescent Electric Lamps and Lighting. By Unit Rasin.....	343
Present Worth Methods—Telephone Engineering. By A. P. Godsho.....	23
Rake, James L. Asphalt Industry, The.....	11
Rasin, Unit. Progress Notes: Incandescent Electric Lamps and Lighting.....	343
Recent Development in V-Notch Weir Measurement. By D. Robert Yarnall and G. A. Binz.....	314
Relation of the Banker to Industrial Chemistry, The. By G. A. O'Reilly.....	562
Rhodes, W. W. Utilization of Nitre Cake, The.....	565
Rice, H. E. Problems in Ignition Development.....	331
Road Building. By J. H. Squires.....	185
Sadtler, Samuel P. Early Chemical Manufacturing in Philadelphia.....	411
Serrill, William J. Address, Retiring President, Illuminating Engineering Society.....	527
Skinner, C. E. Industrial Research and Its Relation to University and Governmental Research.....	546
Smith, Edgar Fahs. Chemical Research in Philadelphia.....	129
Smith Edward Wanton. Notes on the Electric Storage Battery.....	395
Some Random Observations on the Relation of the Junior Member to the Engineers' Club. By S. M. Swaab.....	377
Squires, J. H. Road Building.....	185
Steinmetz, J. A. Automotive of War, The.....	190
Swaab, S. M. As We Pause by the Wayside.....	120
Swaab, S. M. Position of the Engineer in the Community and His Relations to the Contractor, The.....	415
Swaab, S. M. Some Random Observations on the Relation of the Junior Member to the Engineers' Club.....	377
Swaab, S. M. "Vim, Vigor and Victory".....	166
Swanfeld, G. Harry. Indirect Lighting System.....	97
Traffic Department, The (Telephone Engineering). By A. L. Gracey.....	25
Two Conventions. By J. F. McCrudden.....	569
Use of Mean Sea Level as the Datum for Elevations.....	477
Utilization of Nitre Cake, The. By W. W. Rhodes.....	565
"Vim, Vigor and Victory." By S. M. Swaab.....	166
Wagner, Joseph C. What Philadelphia Has Done Toward Regulating and Restricting the Uses of Realty Within the City.....	10
War's Effect on Merchant Shipbuilding, The. By Homer L. Ferguson.....	499
Weather Business, The. By George S. Bliss.....	267
Welfare Work. By J. Caccavajo.....	121
Weller, Francis R. Economics of Power Plants.....	81
What Philadelphia Has Done Toward Regulating and Restricting the Uses of Realty Within the City. By Joseph C. Wagner.....	10
Wolf, Otto C. In Memoriam.....	78
Yarnall, D. Robert, and G. A. Binz—Recent Development in V-Notch Weir Measurement.....	341
Zoning System, The. By Edward M. Bassett, George B. Ford, George E. Datesman, Andrew Wright Crawford.....	173





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